POWER PLANT ENGINEERING

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Modern Plant of Paris Medicine Co.

BOILER ROOM ECONOMY CHIEF AIM IN DESIGN OF SMALL INDUSTRIAL PLANT

IN THE MANUFACTURE of medicines, power is required for such services as mixing, grinding, bottling, labeling, conveying, etc. Besides power, many processes in the manufacture require heat which must be maintained at a definite temperature or certain compounds must go through a series of temperatures in order to give the desired results. Such is the service required of the plant in the Paris Medicine Co.'s factory in St. Louis, Mo., which has been in operation for the past nine months.

This plant is not large, but in its design care was taken to select equipment which would give high economy with as little attention from the operating force as possible; so that for its size and service rendered, without elaborate and expensive apparatus, the plant is a model in many respects of modern industrial power plan arrangement and equipment.

In the boiler room are two Houston, Stanwood & Gamble return tubular boilers. These are each rated at 150 hp., being 72 in. in diameter by 18 ft. in length, and carry steam at 130 lb. pressure. A noteworthy feature of the boiler setting is the steel incasing. This

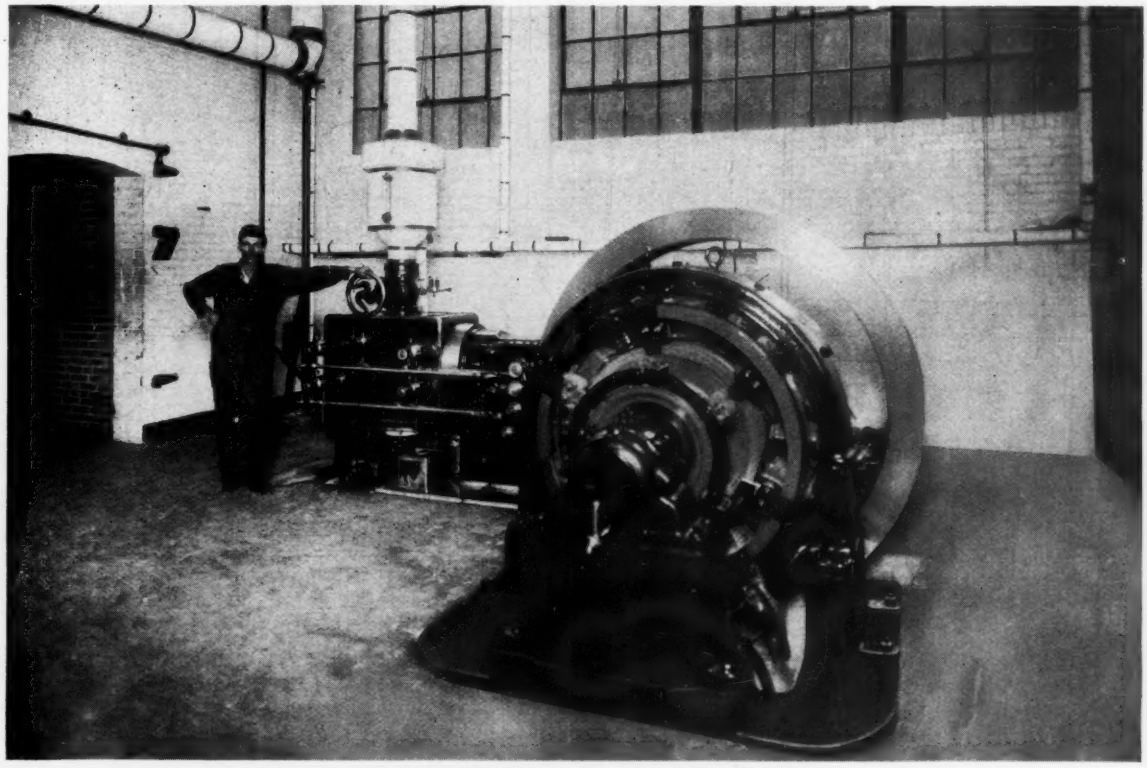

FIG. 1. GENERATING UNIT IN PARIS MEDICINE CO.'S NEW PLANT

is thoroughly air-tight and not subject to cracks as is an all-brick setting; the initial expense, though a little greater, is warranted by the continued higher efficiency of the boiler and lower up keep charges. The casing is lined with fire brick, a 2½-in. layer of nonpareil insulating brick being placed between the firebrick and the steel.

Each boiler is equipped with a Moloch under feed stoker of 200 hp. rating. This type of stoker has a feeding mechanism consisting of a coal hopper which discharges to a ram operated by a steam driven piston. The ram forces the coal into a horizontal retort on which tuyere blocks are mounted for the distribution of air under pressure to the fuel in the retort. Extending from the tuyere blocks to the side walls are dead plates, so named because they have no air openings.

Air under pressure is delivered to the space beneath the dead plates and around the retort. In this space it becomes heated by contact with front, side and bridge walls and the dead plates before passing through the tuyere blocks into the fuel bed. Thus the parts of the stoker and setting beneath the fuel bed are cooled while the advantage of heated air for combustion is gained.

Automatic operation is one of the features of these stokers, the regulation of fuel and air supply being according to the load demands. The speed of the fan is varied in accordance with the steam pressure, an increase in pressure causing a decrease in fan speed and vice versa, by means of a regulating valve. From the shaft of the fan, as will be noted in Fig. 5, a belt operates the selective timers which work the pilot valves and control the admission of steam to the stoker cylinders. The timer may be adjusted manually for five different speeds, the more minute variation necessary for changing load conditions being controlled by variations in the speed of the fan. Thus the operator may regulate the fuel and air supply separately; but once the ratio of air supply to coal is set, the variation in quantity necessary to take care of load changes is controlled automatically, though the ratio remains constant, giving equally good combustion at low or high loads.

The fan equipment here consists of a No. 45 Clarage

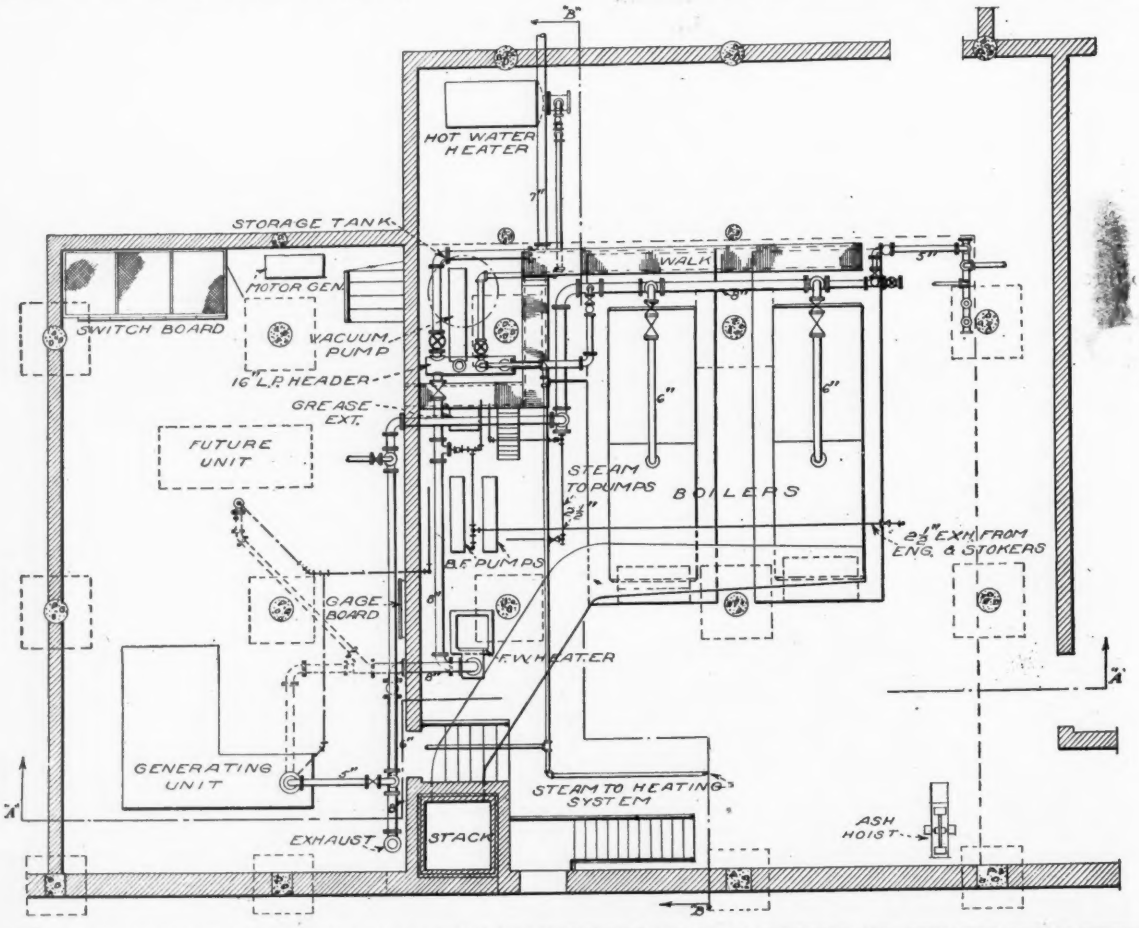

FIG. 2. PLAN OF POWER PLANT SHOWING LOCATION OF MACHINERY AND HIGH PRESSURE AND EXHAUST STEAM PIPING

fan driven at present by belt from a vertical engine, but plans have been made to substitute motor drive, as local conditions indicate better results. For this purpose a 5½-hp. Roth direct-current motor will be used, the speed being regulated through the means of a Cutler-Hammer controller operated in unison with the damper by a Mason damper regulator.

Bayer soot blowers used frequently during operation maintain the efficiency of the boiler at a high point without great inconvenience to the fireman or the necessity of checking down the boiler to any extent.

Besides the special boiler accessories mentioned above are Anderson high and low water alarm columns, Homestead angle blowoff valves and cocks and Golden-Anderson automatic non-return valves and stop valves in the boiler steam leads.

Coal comes to the plant in trucks and is discharged into a storage space of sufficient volume for seven car loads of coal in the basement on the same level with the floor of the boiler room. Wheelbarrows are used to convey the coal from storage to stokers and the ashes from the front of the boilers to the ash bin, from which, when a sufficient quantity has accumulated, a Caldwell motor driven ash hoist carries them up and discharges them into a truck in the alley.

extractor and twin strainer by two boiler feed pumps; these are a Hooker 8 by 5 by 12-in. simplex and a McGowan simplex of like size. Blowoff water is discharged through blowoff and check valves to a basin where it cools before running to the sewer.

The Dunham vacuum heating system is employed for keeping the factory comfortable, the vacuum being maintained by a McGowan simplex vacuum pump, 6 by 12 by 11 in. at about 6 in. of mercury.

Besides this heating system, a steam heating system for industrial purposes fed through a reducing valve and maintained at 50 lb. pressure is supplied from the main steam line. All of the condensate from heating and cooking systems returns to a receiving tank over

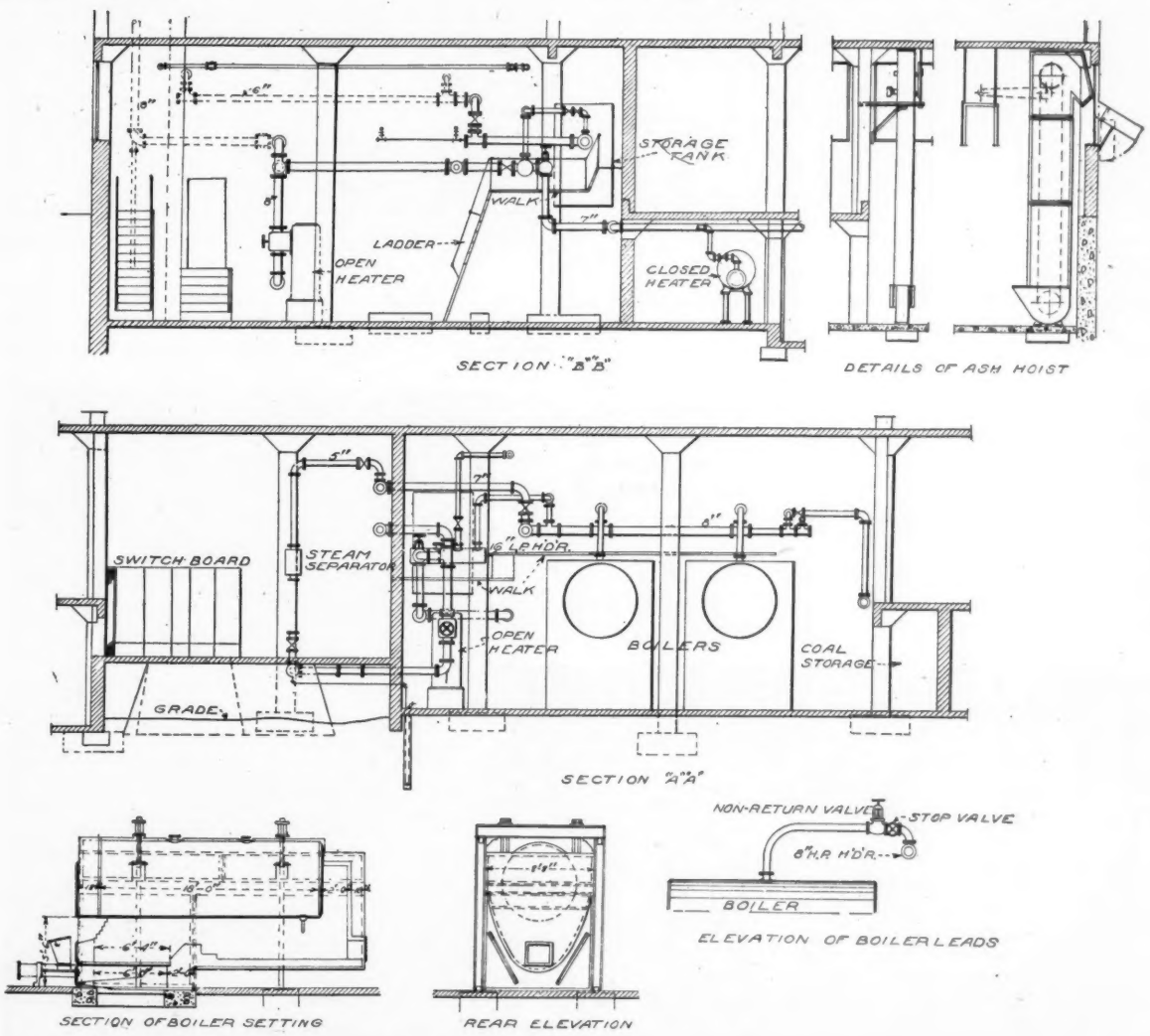

FIG. 3. SECTIONAL ELEVATIONS AND DETAILS OF MACHINERY AND PIPING

Boiler feed water is largely the returns from the heating system which passes to a 500-hp. Cookson open heater. Make-up water is automatically fed to the heater through a float controlled valve on the city water line. Heat is supplied by the exhaust steam which first passes through an oil separator on the heater. The temperature of the water leaving the heater is 210 deg. F. and the water is pumped to the boilers through an Elliott grease

the vacuum pump from which it is discharged to an air separating tank and then to the feed-water heater.

Hot water at 160 deg. F. is used for industrial purposes and is heated in a Sims closed heater by exhaust steam, the temperature being maintained constant by a Weld regulator.

Anderson traps are used to return all high-pressure drips to the feed-water heater, a Bundy trap returns

the condensate from the closed heater and a Johns-Manville ball trap discharges oil drips from separators to the sewer.

In the engine room one unit is now installed with provisions made for another of similar size. This unit

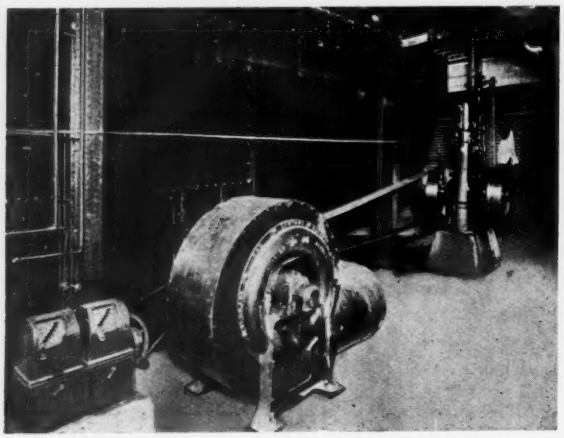

FIG. 5. FAN EQUIPMENT AND TIMING DEVICE

consists of an ideal nonreleasing Corliss valve engine of 126 hp. rating run at 235 r.p.m. direct connected to a 100-kw. direct-current General Electric Co. generator which develops current at 125 v.

Outside current is relied upon for nights, Sundays, and standby in case of accident to the generating unit. This current comes to the plant from the local central station and is converted from 120 v. 3-phase, 60 cycles alternating current to 125 v. direct current by a motor generator set consisting of a Wagner induction motor and a Westinghouse 30-hp. d. c. generator run at 1200 r.p.m.

The switchboard, conveniently located in one corner of the engine room, consists of five panels upon which are mounted the usual instruments and switches for the control of machinery and distribution of current.

Along the dividing wall between the engine and boiler rooms is the gage-board upon which are mounted Foxboro instruments for indicating steam pressure on boiler

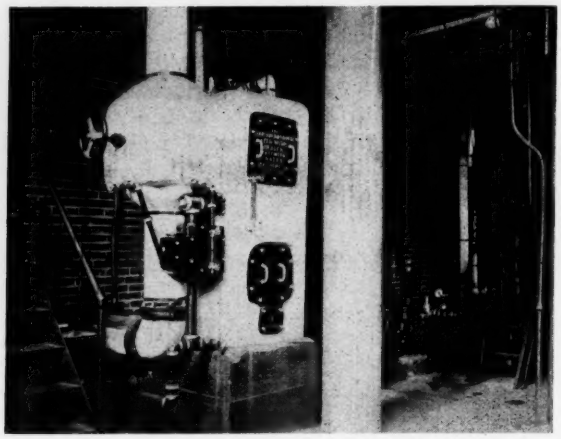

FIG. 6. FEED HEATER WITH PUMPS AND TWIN STRAINER IN BACKGROUND

header, vacuum on heating system, pressure on low-pressure steam system, cold water pressure, hot water

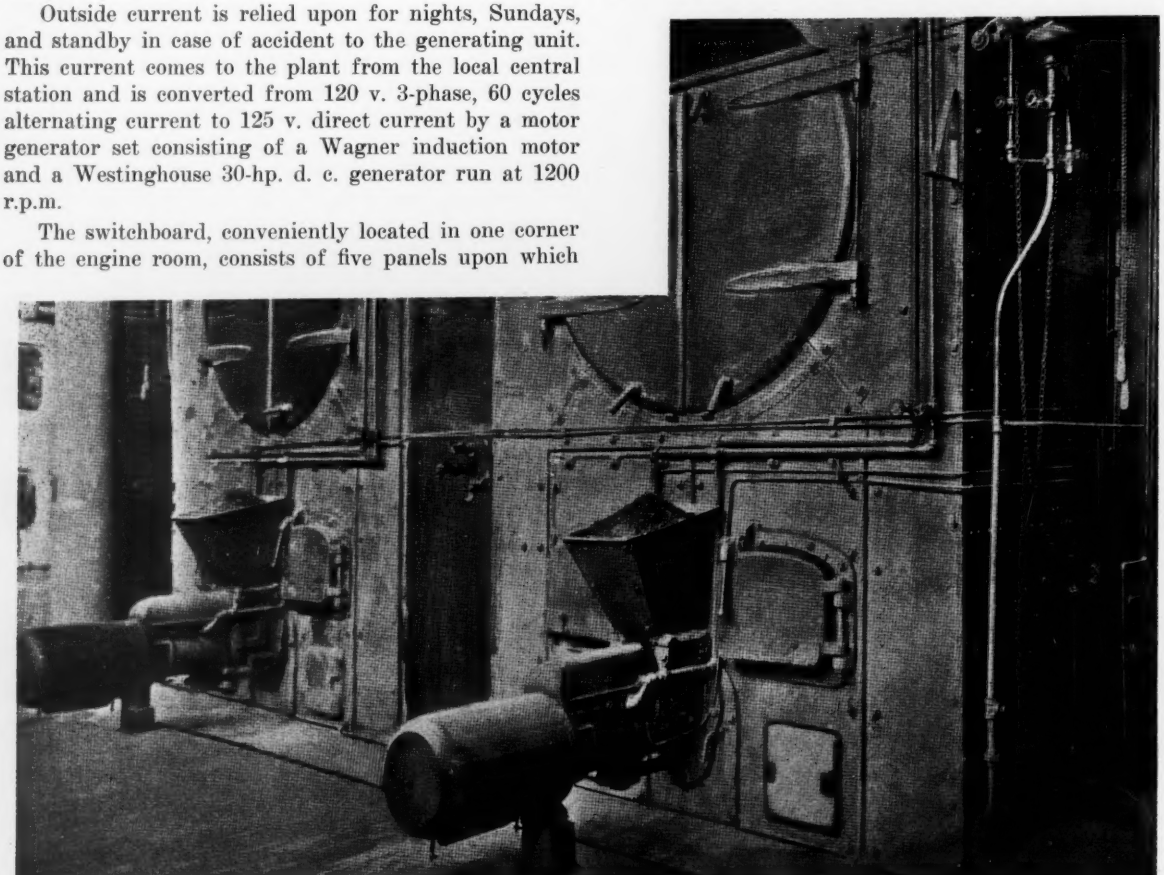

FIG. 4. BOILER FRONTS SHOWING STOKER INSTALLATION

pressure and back pressure on engine, and a recording graphic steam pressure gage.

A small storage battery furnishes current at 25 v. for operating the Couch Autophone system and is charged from the generator circuit.

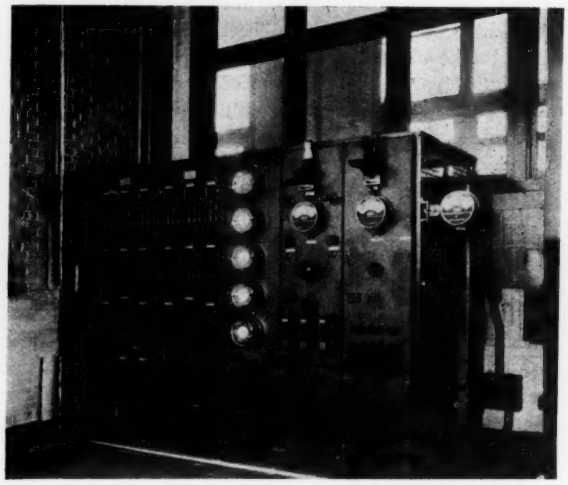

FIG. 7. ELECTRIC SWITCH AND INSTRUMENT BOARD IN ENGINE ROOM

The engineering work in connection with the design of the plant and the erection of machinery was done by Herbert H. Morrison, mechanical engineer of St. Louis, and the operation of the plant is in charge of Gus Hempleman, chief engineer, to both of whom we are indebted for courtesies extended during the preparation of this description.

Hints on Coal Storage Pile

IT IS common practice to limit the height of a coal pile, this for two reasons: A pile too high crushes the lower layers of coal, producing more fines; the larger the pile the less heat-dissipating surface there is exposed in proportion to the heat generating capacity of the pile. Twelve feet in height is a common limit.

Whatever precautions are taken in choice and handling of coal, provision should be made for keeping track of the temperature rise in a coal pile and for rapid re-handling of portions of a pile in case of excessive heating. In a coal pile covering a considerable area, it should be so subdivided that in case of spontaneous combustion of a portion, the heat will not be transmitted to the whole pile, thus accelerating the heating of portions of the pile which normally would have remained cool.

To keep track of the temperature of coal piles, it is recommended that ½-in. iron pipe be driven vertically into the pile at distances of 15 or 20 ft. apart. A maximum thermometer lowered into the pipe to varying depths will indicate the temperature of the pile opposite the thermometer.

A survey of the pile and a survey of the temperature of all parts of the pile should be made twice a week during the first three months after the pile is made, and once a week thereafter until the pile has evidently ceased to heat. As soon as any portion of the pile reaches a temperature of 150 deg., provision should be made for removing that portion of the pile. Actual removal need not begin until the temperature has reached 180 deg., but at these temperatures the rate of oxidation is dangerously rapid. The object of re-handling the coal is to allow it to cool below a dangerous temperature. Any method of re-handling which does not allow of cooling will only transfer the difficulty from the old pile to the new one. It is usually useless to employ water in an attempt to cool a coal pile.

Lack of provision for rapid re-loading, cooling, and re-piling of coal is the cause of serious losses from spontaneous combustion.

War Substitutes

ECONOMY for Waste.
Co-operation for Criticism.
Knowledge of Prices for Gossip about Profits.
Cornmeal and Oatmeal for Wheat Flour.
Fish for Beef and Bacon.
Vegetable Oils for Animal Fats.
The Garden Hoe for the Golf Stick.
Performance for Argument.
Service for Sneers.
Patriotic Push for Peevish Puerilities.
Perishable for Preservable Foods.
Greater Production for a German Peace.
The Beef You Do Not Eat for the Rifle You Cannot Carry.
Conservation for Conversation.
Common Sense for Common Gossip.
Marketing for Telephoning.
Production for Pessimism.

—Canadian Food Bulletin.

The Proper Way to Pack a Gage Glass

SEE THAT your gage cocks are set absolutely true, as otherwise the glass will have too little space for expansion on one side.

When screwing up the glands, you should be careful not to get them too tight. If you have the proper washer of the correct size—finger tight is sufficient, just so that you can move the glass with your fingers—this will allow for the expansion when under the pressure and the heat. Screw up your gland just beyond the leaking point and you will get the best of results with the Ironclad glasses, the longest service and the best general all around satisfaction that you have ever known.

THE FOLLOWING average weights per brake horsepower for various classes of engines were given in a paper by Mr. P. N. Everett, recently read at Newcastle-on-Tyne: Triple expansion steam engine for cargo boat (no boilers or auxiliaries), 130; triple expansion, including boilers and auxiliaries, 450; Diesel engine for cargo boat (no auxiliaries), 250; Diesel engine with all auxiliaries, 400; turbines, for cross-Channel boat with boilers and auxiliaries, 200; Diesel engines for submarines, 50; steam reciprocating engines for destroyers, 35; turbines for destroyers, with boilers, etc., 30; petrol engines for motor cars, 15; petrol engines for racing boats, 7½; aero engines, 2½.—Compressed Air Magazine.

Adapting Furnaces to Available Coal

PROPORTIONS AND ARRANGEMENTS OF BAFFLES AND ARCHES IN HAND-FIRED FURNACES. BY OSBORN MONNETT

IT HAS been the practice of many steam users to buy a coal best suited to the conditions of their plants regardless of how far that coal may have to be shipped, instead of equipping the plants to burn coal available in their immediate vicinity. This practice has been brought about in an effort to avoid investment in furnace equipment, as it was thought a good policy to pay a little more for a good grade of coal than to tie up money in facilities for burning a poorer grade.

This has led to a number of abuses and imposes an unnecessary hardship on the transportation facilities of

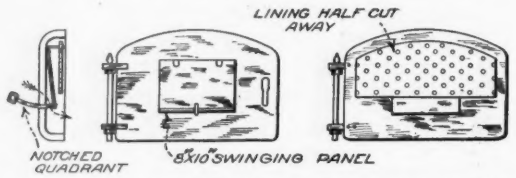

FIG. 1. DETAILS OF PANEL DOOR TO ADMIT AIR AT DEADPLATE

the country. An extreme case of this may be cited in that of a cement mill in northern Illinois located directly above a coal mine—the shaft of the mine coming up a few hundred feet from the boiler house. Yet for years every pound of coal burned in that plant was shipped in from a distance of over 200 miles.

In normal times, this is bad enough; but in times like the present, with our transportation machinery overloaded with important war work, such a situation should not exist—hence the Zoning Order.

As a matter of fact, the policy depending on a coal foreign to the locality, is in most cases short sighted. Evidence of this may be found on every hand. A certain Chicago laundry, with an inadequate boiler setting, used a high grade high priced steam coal in order to carry its load. The furnace was finally remodeled to burn a low grade cheap coal and the saving in fuel cost was at the rate of $3000 a year besides saving the price of an additional boiler which had been contemplated under the old conditions.

GRATE SURFACES

AS A GENERAL STATEMENT, coal in this country lowers in quality from the East towards the West and certain users are naturally inclined to favor the coal which lies to the east of them. What does the Zoning Order mean to the plant which, for one reason or another, has fallen into this practice? It means primarily in most cases a readjustment of grate surface. The poorer the quality of the coal, the less potential energy will be turned into the furnace with each shovelful, and in order to develop the same amount of heat more grate surface must be provided.

Broadly speaking with relation to grate surface, plants may be classified as those east of the Mississippi and those west. The table gives the recommended dimensions for the various sizes of return tubular boilers East and West.

With increase of ash content in the coals of the West, it is desirable to increase facilities for ash and clinker removal. Coals which have been avoided in the past owing to the amount of sulphur they contain will have to be burned now. Sulphur offers a disturbing element with regard to clinker formation and shaking and dumping grates will be an advantage in handling this class of fuel.

AUXILIARY AIR

PERHAPS THE most conspicuous characteristic of the western coals is their increased proportion of volatile matter as compared to the total combustible in the fuel. Special means must be provided to burn this volatile matter in order to obtain economical results. Experience has shown that high volatile coal does not and can not get enough air through the grate to burn the gases completely. When ⅓ to ½ of the fuel value of the coal is represented in gaseous matter, it can be appreciated that air must be admitted over the fire.

The best place to admit air is at the dead plate through a panel door discharging downward as shown in Fig. 1. Various experiments have been made with air admission at the bridge wall, along the sides of the furnace, etc. To be of any advantage, the air must be heated and mixed with the hydro-carbon gases as they pass through the combustion chamber. By admitting the air at the dead plate, it is not only heated by the fire itself but is mixed with the gases as it scrubs over the fire and is in better shape to unite with them when it next passes over the bridge wall.

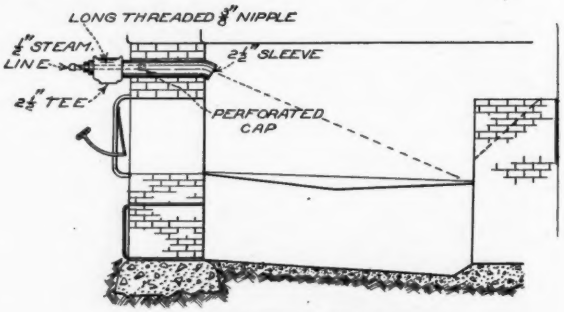

FIG. 2. AIR SYPHON STEAM JET

Steam jets of the air syphon type, as in Fig. 2, will cause a mixture of the air and gases and result in advantage in many cases. If used, they should be applied above the fire door and spaced equally across the setting on 18-in. centers. In using, the steam valve should be cracked open just enough to get a good mechanical mixture of the air over the fire, as it is the air and not steam that is desired. When used in this way, a very small amount of steam will give good results.

HEIGHT OF SETTING

THIS IS a subject upon which there has been a great deal of experimentation. Many have gone to the extreme on this point and recommended settings which were not

economical. It must be remembered that direct radiation from the fire is the best form of heat transmission, and as this varies inversely with the square of the distance, too much space over the fire will lower the efficiency of the setting.

There is no special advantage to be gained in setting a 150-hp. boiler higher than 36 in. from dead plate to shell. The height should be governed largely by the disposition of the furnace construction in the combustion chamber, other things being equal; the heights between the dead plate and shell given in the table are ample to furnish in any reasonable construction at this point.

For boilers that have already been installed with too low a setting, enough height over the grates may many times be obtained without going to the expense of raising the setting, simply by casting a new dead plate at an angle gaining 6 in. in front and pitching the grate 1 in.

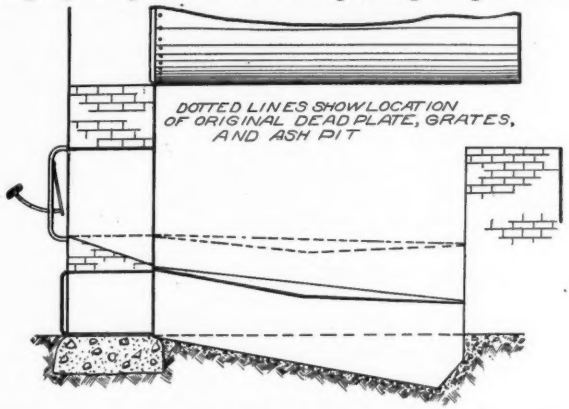

FIG. 3. SPECIAL DEADPLATE FOR GAINING HEADROOM WITHOUT RAISING BOILER

to the foot from this point to the bridge wall as shown in Fig. 3.

A high bridge wall is an advantage. It offers a refractory surface upon which the products of combustion may impinge, thus aiding in the mixture of volatile matter and air so necessary to good combustion. Of course, enough area must be left over the bridge wall. This is generally taken at 25 per cent of the grate surface in free opening between top of bridge wall and shell. Do not slope the face of the bridge wall back as in dotted lines, Fig. 2. Make it perpendicular for best effect.

IGNITION

AS A GENERAL STATEMENT, it can be said that bituminous coals do not need artificial ignition when burned in hand fired return tubular boiler settings. The heat of the fire itself furnishes all of the ignition necessary. This makes possible the use of flush front settings in which space is minimized and advantage is taken of direct radiation of the fire to the shell. Some of the coals in the West, such as lignites, etc., might to advantage be burned in modified types of dutch oven settings. This would aid in increasing the rate of combustion and to a certain extent reduce the grate area necessary for capacity, which area becomes excessive in some cases where large amounts of moisture are contained in the fuel. All coals that can be burned without a dutch oven setting should be, because of the extra first cost, radiation losses, depreciation, floor space, etc., taken up by such settings.

COMBUSTION CHAMBER

AS FAR AS the volume behind the bridge wall is concerned, there is one item at least that should not be

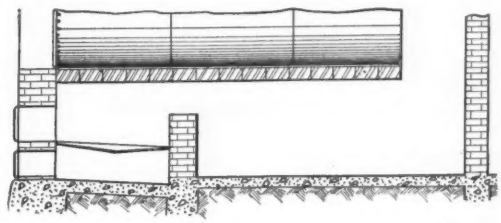

FIG. 4. LONG ARCHES WITHOUT MIXING DEVICES GIVING POOR ECONOMY

neglected; that is to excavate the combustion chamber to a level with the floor line and pave the floor, to facilitate the cleaning-out process.

While it is necessary to burn the volatile matter to advantage in order to obtain economy with high volatile coals, brickwork in the combustion chamber should be limited to construction for mixing the gases. The length of flame travel will not do this, nor will plain arches underneath the shell. Experience has shown that in long passages the hot gases stratify and do not get sufficient mixture for economical combustion. In one experimental case an arch was constructed the full length of the boiler,

GRATE SURFACE AND HEIGHT OF SETTING RECOMMENDED FOR HORIZONTAL RETURN TUBULAR BOILERS

Boiler Size	East of Mississippi	West of Mississippi	Height of Setting
In. Ft.	In. long In. wide	In. long In. wide	Inches
42 by 12	42 by 42	48 by 48	28
42 by 14	48 by 42	54 by 48	28
48 by 12	42 by 48	54 by 48	30
48 by 14	48 by 48	54 by 54	30
48 by 16	54 by 48	60 by 54	30
54 by 14	48 by 54	60 by 54	32
54 by 16	54 by 52	60 by 60	32
60 by 16	60 by 60	66 by 72	34
60 by 18	66 by 60	66 by 78	34
66 by 16	60 by 66	66 by 78	34
66 by 18	66 by 66	72 by 78	34
72 by 16	66 by 72	78 by 78	36
72 by 18	72 by 72	78 by 84	36
78 by 18	72 by 78	78 by 96	38
78 by 20	78 by 78	84 by 96	38
84 by 18	78 by 84	84 by 102	38
84 by 20	78 by 84	84 by 102	38

Fig. 4, the only effect being to reduce the steaming capacity of the boiler.

Gases may be allowed to come in contact with the shell of the boiler if at the same time effective means are provided for mixing them before they are reduced in temperature to a point below that of ignition.

There are a number of standard types of constructions for combustion chambers. Of these, two are in general use:

First: Mixing of gases by impinging on hot bulkhead surfaces; typified by the well known double arch bridge wall setting, Fig. 5.

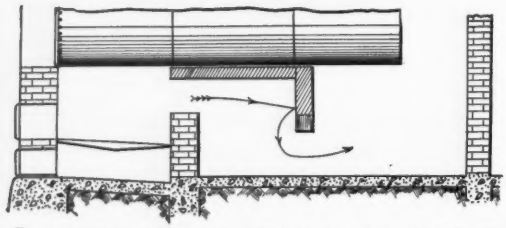

FIG. 5. MIXING GASES BY IMPINGING AGAINST FIREBRICK BULKHEAD

Second: Mixing by squeezing while their temperature is still above the ignition point.

In Fig. 6, this is accomplished while the gases are in direct contact with the heating surface, just after they have left the fire bed itself. This illustrates the importance of *quick and positive mixture,* rather than long lengths of flame travel or isolation of the gases from cooling influences.

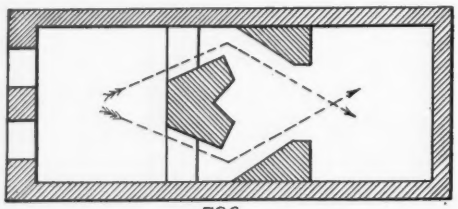

FIG. 6

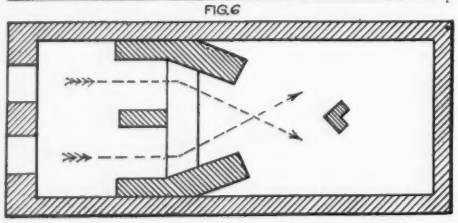

FIG. 7

FIG. 6. MIXING GASES BY SQUEEZING IN DIRECT CONTACT WITH HEATING SURFACE (MISOSTOW'S FURNACE)

FIG. 7. MIXING GASES BY SQUEEZING IN HIGH TEMPERATURE ZONE (TWIN FIRE FURNACE)

The twin fire furnace discharges the gases into a high temperature zone over the bridge wall, squeezing them between converging reverberatory surfaces, thus utilizing the elusive volatile matter which frequently gets away unburned in the ordinary setting.

What Did You?

By Douglas Malloch

WHEN the war has been won,
When our duty is done,
When our sailors come sailing the foam;
When our men of the air
And the guns over there
All the nation is welcoming home;
They will come to your door,
The young winners of war,
They will look you up, over and through,
And in word, or in thought,
They will ask, like as not:
"Well, we did quite a lot—
What did you?"

When the years have gone by,
And the pages are dry
That the story of struggle record,
With democracy sure,
When we're living secure
In the strength of our soul and our sword,
In that glorious time
To your knee there will climb
Then a boy or a girl, or the two,
And will say, "Some were brave
On the land and the wave,
Some their ev'rything gave—
What did you?"

Or it may be at night
You will sit by the light
Of a fire in a home that is free,
You will sit all alone
'Neath a roof of your own
In some year of the future to be;
And a voice down inside
Will say, "Some of them died,
Or they suffered their duty to do,
And the ones who could not
Give their all gave a lot,
Gave their money—say, what,
What did you?"

Honey Uses in the Home

THE SWEETENING QUALITIES of honey as a substitute for sugar in foods is discussed in Farmers' Bulletin 653, issued by the Department of Agriculture. The food value, flavor, wholesomeness and economical uses of honey are thoroughly discussed. The quantities to be used when honey is to take the place of sugar are practically the same, except that a cup full of honey carries about 1/5 water, so that much less liquid should be used in mixtures.

This bulletin also has recipes for bran, brown bread, steamed brown bread, honey bread, honey and nut bran muffins, all of which are made without wheat flour. Recipes for a number of honey desserts and candies are given, as well as directions for using honey in preserving.

TEST FOR CO_2, carbon dioxide, content of the flue gases is one of the simplest and best checks on efficient operation of the furnace. A test which shows 10 to 13 per cent CO_2 indicates good conditions. As high as 14 or 15 per cent may be obtained by special care. Less than 10 per cent indicates something wrong which should be remedied. Over 15 per cent is likely to indicate insufficient air supply, and a test for CO should be made. If more than a trace of CO, carbon monoxide, is found, more air must be furnished by running a thinner fire, or supplying extra air, preferably heated, above the fuel bed.

Oil Engines---II

Vaporizing and Mixing

ONE of the most serious problems attending the utilization of the heavier hydrocarbons such as kerosene, fuel oil and crude oil in internal combustion engines is the conversion of these fuels into vapor before or during their mixture with air. In the majority of engines, a hot chamber or vaporizer is provided by means of which the oil, after being introduced, is converted into a vapor, the most commonly and generally employed arrangements for this purpose being as shown in Figs. 8, 9 and 10. In the scheme shown in Fig. 8, the oil is injected into the chamber at the left of the cylinder and is mixed with the proper portion of air, also delivered to this chamber from the cylinder upon the upward stroke of the piston. The charge is then ignited principally by direct contact with the hot walls of the chamber, although some of the heat used for this purpose is that due to compression. After the chamber

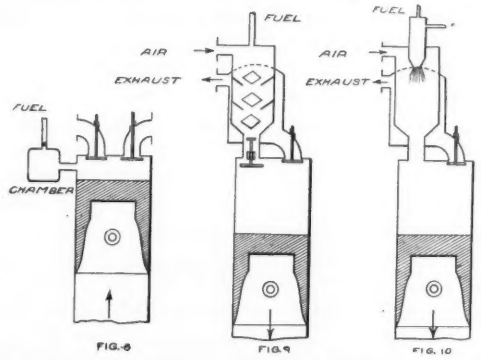

FIG. 8. IN THIS ENGINE FUEL IS VAPORIZED IN CHAMBER SHOWN AT LEFT

FIG. 9. WITH THIS ARRANGEMENT, FUEL IS VAPORIZED BY COMING IN CONTACT WITH HOT BAFFLES

FIG. 10. COMPRESSED AIR IS HERE INTRODUCED TO ASSIST VAPORIZATION OF FUEL

has been heated to the required degree by means of a lamp provided for the purpose, it is retained at a red heat by the combustion of the mixture within it.

A somewhat more complicated arrangement and one employed by many manufacturers of gasoline engines to adapt their engines to the use of the heavier oils is that shown in Fig. 9. Contained within the enlarged exhaust passage is a chamber fitted with baffle plates and connected to the air and fuel supply lines and the inlet valve of the engines in the manner indicated. The fuel is dropped as required upon the baffle plates which, being highly heated by the surrounding gases of the exhaust, at once convert the liquid into a vapor; this then intimately mixing with the heated air, is caused, by the downward stroke of the piston, to pass through the chamber.

The third arrangement, that shown in Fig. 10, is similar to the one illustrated in Fig. 9, except for the absence of the baffle walls in the heating chamber and the use of compressed air introduced at a pressure of from 8 to 25 lb. and employed to mix with and break up the oil as it is fed to the engine. This process provides a finely divided spray, which, due to the oil coming in contact with the heated chamber walls, is readily vaporized.

These vaporizers, while simple and cheap to construct, have a number of faults, chief of which, of those

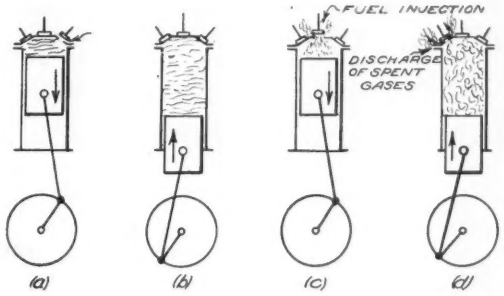

FIG. 12. CYCLE OF EVENTS OF DIESEL ENGINE

types shown in Figs. 8 and 9, is the practical impossibility of vaporizing the fuel completely at all loads and under all conditions augmented in the case of the former by more or less ignition trouble. And, with the types of vaporizers illustrated in Figs. 9 and 10, the capacities of the engines in connection with which they may be employed are materially reduced, on account of the decrease in weight of mixture brought about by preheating, and the throttling action which this form of device has on the free flow of both the fresh charge and the exhaust gases. The fuel consumption of these engines averages about 1 lb. of oil per brake horsepower-hour, corresponding to a thermal efficiency of no more than 15 per cent.

A type of engine possessing many features of advantage over those just discussed is the Diesel, in which dur-

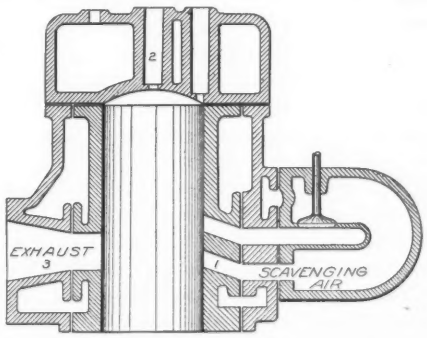

FIG. 13. SECTION THROUGH CYLINDER OF TWO-STROKE CYCLE ENGINE

ing the compression stroke the cylinder contains air only. This is compressed to such a pressure, generally about 500 lb., that the corresponding and resulting temperature is sufficiently high to ignite the fuel injected into it. This injection is gradual, by means of an air blast and at pressure of about 250 to 500 lb. in excess of that due to compression. As a result, the fuel is not only thoroughly atomized, but is caused to mix intimately with the highly compressed and heated air; vaporization and ignition follow immediately.

Operation of the four-stroke cycle Diesel engine may be readily understood by referring to Fig. 12. With the downward stroke of the piston as indicated at (*a*) the inlet valve is open and air admitted to the cylinder which, upon the upward stroke (*b*) and with all valves closed, is compressed to about 500 lb. At this point, and with the piston commencing its downward stroke (*c*), fuel oil is sprayed or atomized into the cylinder during a definite period of this stroke, which then, due to the resulting burning and expansion, becomes the working stroke. On the following upward stroke (*d*), the exhaust valve opens and the burned gases are expelled, making the engine ready for the repetition of the cycle.

With the assistance of Fig. 13 the two-stroke cycle engine may be described. Assume that the piston is at the lowest point of its stroke, and as a result openings 1 and 3 for air and exhaust respectively are uncovered. As the piston travels upward they become covered and the air contained within the cylinder is compressed to

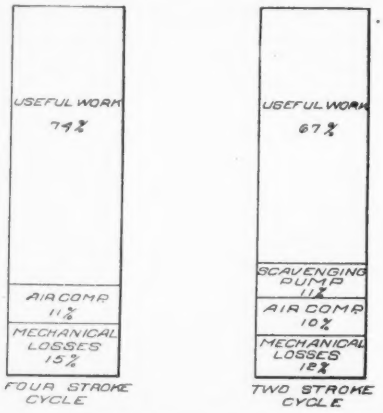

FIG. 14. COMPARISON OF EFFICIENCIES OF TWO-STROKE AND FOUR-STROKE CYCLE ENGINES

about 500 lb. per sq. in., accompanied by a rise in temperature to about 1000 deg. F. Valve 2 then opens, fuel is injected, ignition occurs and, due to the expansion resulting from the burning of the gases, the piston is forced downward on its working stroke. With the uncovering of exhaust opening 3, the gases rush out through this passage, and as the piston descends still further, opening 1 is uncovered and air under a pressure of from 5 to 6 lb. per sq. in. is forced into the cylinder sweeping before it and out through the exhaust passage the remaining spent gases. The piston then again moves upward and as before compresses this fresh charge preparatory to repeating the cycle.

Comparative mechanical efficiencies of two and four-stroke cycle Diesel engines are shown in Fig. 14, from which it may be noticed that the former, due to the added power requirements of the scavenging process, has a somewhat lower mechanical efficiency than the four-stroke-cycle unit.

DELIVERIES of steel ships are reported by the Emergency Fleet Corporation to have passed the 1,000,000-ton mark on May 25.

JOIN THE ARMY behind the Army—be a war saver.

The Care of Turbine Equipment

BY W. LITZLER.

WHILE of late much has been published in engineering magazines on the subject of steam turbines, but little is said relative to their general care.

Of primary importance is oiling and this, under all conditions, should be given the closest attention and never left to chance. All bearings, including those of the governor, must have a sufficient supply of oil and the main system should be well filled, as otherwise the pumps will become air bound, thus causing trouble at the very start.

Look over the turbine carefully and note any excessive vibration. This may be due to several causes including operation under light load.

If a vertical turbine, pay close attention to the step bearing. If a horizontal turbine, watch closely all water and steam seals for the breaking of these may allow air to enter the casing, thus cooling the rotor at that point and perhaps causing unequal expansion with resulting vibration and rubbing. If excessive, this may do material damage and also cause a reduction in vacuum, a thing to be guarded against at all times.

Racing may occur, due to any one of several causes, such as dirty oil in the mechanism of the governor or pilot valve, or excessive lost motion in the valve gearing.

Another portion of a turbine installation requiring particular attention is the condenser and if this is of the surface type the tubes must be kept clean. And if after being tested you may find any leaky tubes due to splits or poor packing, those should be replaced or repaired as may be required; for, in addition to crippling your vacuum, such a condition may prevent the re-use of the condensed steam as boiler feed, especially if the circulating water can not be used for steam making purposes.

With the air pump in operation and a partial vacuum in the system, leaks may be discovered readily by passing the flame of a candle or torch over all joints or suspected defective parts. When any leak does exist the flame will be drawn inward and by marking such joints with chalk they may be again found later when repairs are to be made. If a split tube, remove ferrules and packing and replace with a new one or block off entirely with plugs; if packing leaks, renew it.

Attention should also be given to the priming lines on your pumps; for if these are not in good condition, you may lose the prime on all your apparatus, causing considerable trouble and perhaps service interruption.

Take care to see that all pumps are properly packed, as often you will find the packing in the stuffing boxes not as it should be. After having inserted packing and lantern wick, see that the following turns are open at top so that sealing water may escape and thereby indicate proper sealing of the glands. If this is not done, it will be difficult to determine whether you are getting sealing water on the glands.

Air pumps also require considerable attention. See that their glands are properly sealed, that all strainers are kept clean and be certain all parts are properly oiled. Boxes should be packed carefully and in regard to seal-

ing water, the same precautions should be taken as in the case of the circulating pumps.

The same care and attention must be given your wet vacuum pumps. You may find often that they refuse to handle properly the condensation at full or overload, that your sealing rings or impellers or both may be somewhat worn and the pump will not do its work properly. The only remedy is a complete and thorough inspection of all parts.

In priming a condenser and pump, do not open the priming valve too fast, as doing so may cause the entire loss of prime on the remaining apparatus. It is best just to crack the valve and allow the prime to build up very slowly; however, in the event of an emergency, you can prime from your air line, although this should be done only by one sufficiently capable.

Air and vacuum lines should be watched closely for leaks around valve stem and at all connecting points. It is poor policy to allow any unit on the air line if the condenser is not up to the mark, as it will only drag the others down. It is preferable to put on its own air pump and let it travel alone, as the good ones will not make the bad one good, but the bad one will make the good ones bad and you will find quite a difference in the vacuum after making this change.

There is other apparatus requiring attention, such as step pumps, accumulators, water pumps, exciters, etc., and don't forget that eternal vigilance is the watchword for good service.

Conserve Tin

THERE is a widespread belief that the cost of genuine babbit can be cheapened without injury to its quality by the addition of lead, and also that the quality of a lead base metal can be improved by increasing the tin content—this latter idea being based, no doubt, on the principle that if a little tin is good, more tin is better.

Without knowledge of the effect produced in alloying certain kinds and proportions of metals, it is an easy matter to fall into grave errors in compounding babbit.

Notwithstanding that these intermediate grades of babbit are constantly being used and recommended by various manufacturers, it is a fact that no babbits based on such formulas have ever been popularized because they can only be used successfully under most favorable conditions or forced lubrication, and they can generally be counted on to fail under heavy pressures, high speeds and scant lubrication. They will not stand up under a crucial test chiefly because of their low fusibility which makes them highly susceptible to the influence of frictional or initial heat.

These intermediate grades of babbit seem to be most desirable as far as outer appearances go; they will also stand the usual physical tests of hammering, cutting and bending. But when these alloys are put in service, sooner or later they give trouble which is generally attributed to some mechanical defect or to the lubrication as users are in the dark as to any other probable cause.

As stated before, the chief trouble in using these intermediate grades of babbit is caused by their low melting points, and the examples given further on will make clear the extent to which alloys of tin, lead and antimony are influenced by certain mixtures.

The melting point of a strictly genuine babbit and also a strictly lead base babbit, are both around 500 deg. F. This is about as high a melting point as can be obtained in a babbit alloy. The melting point of a babbit is always lower than the arithmetical mean and variations from certain rules in mixing reduce the melting point below the melting point of the most fusible metal in the alloy.

As an illustration, take a mixture of 87 per cent lead and 13 per cent antimony; the melting point of lead is 619 deg. F. and of antimony 834 deg. F. It would be most natural to suppose that adding antimony to lead would bring the mixture to a higher melting point than lead, and as the mean melting point figures 645 deg. F., it would not be unreasonable to expect to obtain at least the melting point of lead, but as a matter of fact the melting point of this alloy is 477 deg. F. This is the lowest melting point of the series of lead and antimony mixtures, and forms what is termed as eutectic.

When we come to tin and lead mixtures, we have two eutectics or low melting points—one around 60 per cent tin and 40 per cent lead which melts about 336 deg. F.; the other around 60 per cent lead and 40 per cent tin which melts around 412 deg. F. This last mixture is known commercially as "wiping solder" and is used for that purpose by plumbers because it remains in a pasty stage in cooling throughout 70 deg. F.

The foregoing illustrations show why babbits made along these lines are foredoomed to give trouble if there is put upon them any stress that raises the temperature, or the lubrication is lacking in either quantity or quality. The admixture of certain other metals in babbit alloys or the presence of certain impurities also contribute toward bearing troubles.

Apparently there are only two grades of babbit metals worth considering for bearing purposes—one strictly genuine babbit; the other a properly balanced lead base metal. Of these two compounds the lead base metals are in most general use on bearings that are well seated or soldered to their backings. There seems to be ample evidence that lead base metals wear well, run cool, absorb little power and are less dependent upon lubrication than the other; they also stand up well under heavy pressures and high speeds and appear not to be affected injuriously by grit and dust.

The chief virtue of a genuine babbit is its malleability, which enables it to withstand distortion under shock from pounding on loose shell bushings. Babbit users who are prejudiced in favor of genuine babbit or the intermediate grades, can undoubtedly use a high grade lead base metal on a majority of their bearings with both benefit and economy and at the same time help conserve the tin supply, which is most important at this time.

GIVE OUR BOYS in the Army and Navy every fighting chance. Pledge yourself to save to the utmost of your ability and to buy War Savings Stamps.

DON'T WAIT to be urged to join the W. S. S. army. What if our men in the trenches waited to be urged?

THE MODERN WORLD OF BUSINESS IS INTERNATIONAL. FREE AND CLOSED SEAS. EARLY EFFORTS AT ECONOMIC PRESSURE. BY HERBERT S. HOUSTON, MEMBER OF THE CHAMBER OF COMMERCE OF THE U. S. A., ON ECONOMIC RESULTS OF THE WAR*

IN considering the grounds on which American business men base their belief in the value of economic pressure as a force for the maintenance of peace, it is necessary to present a brief survey of the organization of the modern world. The controlling idea in that organization is interdependence. And the essential factor in interdependence is communication. The agencies for quick communication have become so familiar that their significance, as a rule, is quite overlooked. Beginning with the printing press, these agencies have increased in number and speed to the point where there seem to be no longer frontiers of the possible; if there still are, in some souls, they are assuredly being crossed and recrossed. Following the post, by ship and coach and train, came the telegraph by land and sea, the telephone, and then, as a capping achievement, the wireless. This power of quick communication developed endless relationships, all bearing their part in creating and maintaining a world-wide interdependence. For communication has respected national boundaries no more than the winds of heaven.

In this modern world business can be broadly defined as its organized commercial life, in the three great divisions of production, distribution and consumption. Business, in each of these divisions, is international. It employs the one truly international language, that of figures, understood in every country. Today money is international because it has gold as a common basis. Credit based on gold is international. Commerce based on money and on credit is international. Then the amazing network of agencies by which money and credit and commerce are employed in the modern world are also international. How closely interrelated all these agencies are was shown in a dramatic way when the great war broke. Instantly stock exchanges throughout the world were closed. Moratoriums were declared in nearly every country. This was not due to the fact that the world had suddenly become bankrupt, but it was due wholly to a breakdown of the machinery through which the business world carried on its affairs. In brief, it came from a breakdown in the agencies of international communication. The world-wide disturbance that was immediately caused threw into high relief the fact that all nations had been bound together, chiefly through the development of commerce, into an interrelated and interdependent organism. It showed to even the most self-centered and self-sufficient country that it was part of a great whole. Not one among them, however strong, could stand alone. It is the growing understanding of this fact, which the war has embedded in the consciousness of the world, that gives the underlying hope for a league of nations.

As all suffer through war, all must combine to lessen the danger of wars. And that tremendous purpose, to find a sane and practicable way out of war, has become one of the great purposes of the war. As the League to Enforce Peace expressed this purpose in these two graphic declarations: "Make the world safe by defeat of German Militarism" and "Keep the world safe by a League of Nations." And Viscount Grey gave expression to the necessity for such a league in these memorable words: "Unless mankind learns from this war to avoid war, the struggle will have been in vain. Over humanity will loom the menace of destruction. If the world cannot organize against war, if war must go on, then the nations can protect themselves henceforth only by using whatever destructive agencies they can invent, till the resources and inventions of science end by destroying the humanity they are meant to serve."

And the English statesman who preceded Viscount Grey in the Foreign Office, Lord Lansdowne, points out the path, on which the best judgment of the world is centering, that must be followed if that catastrophe is avoided. Lord Lansdowne said, "If the Powers will come under a solemn pact and bind themselves to submit future disputes to arbitration; if they will undertake to outlaw, politically and economically, any one of their number which refuses to enter into such a pact, or to use their joint military and naval forces for the purpose of coercing a Power which breaks away from the rest, they will indeed have travelled far along the road which leads to security."

We hold it to be of the utmost importance, as President Wilson has just emphasized, that such a league should not merely be contemplated as a more or less remote outcome of a future settlement, but should be put in the very forefront of the peace terms as their presupposition and guarantee."

The support for the League of Nations plan in America has been as influential and widespread as in England. President Nicholas Murray Butler of Columbia University, in an address before the Chamber of Commerce in St. Louis, February 16th, 1918, said:

"A league to establish and to enforce the rules of international law and conduct is now in existence, with the United States as one of its most potent members. This league should be a permanent addition to the world's organization for order and for peace. Upon its firm establishment three consequences will almost necessarily follow. First, there can be no separate alliances or ententes of a political or military character between nations included in the league, and this league must aim

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to include the whole civilized world. Second, there can be a speedy reduction of armaments, both to lighten the burdens of taxation and to turn the minds of nations away from international war, to prevent which will be such a league's chief aim. Third, the most favored nation clause must be made applicable to all members of the league whenever treaties of commerce are concluded between any two or more of the nations that are included in it. This will either greatly lessen or wholly remove one of the strongest economic temptations to international war."

As indicating how generally the responsible opinion of the world has centered on this program, these words of President Wilson are significant because they restate his unchanging belief in "the partnership of nations which must henceforth guarantee the world's peace. That partnership must be a partnership of peoples, not a mere partnership of governments.

Free Seas and Closed Seas

President Wilson in his notable statement of war aims of the United States, in his address to Congress, January 8, 1918, to which reference has been made, presented an exception to the free use of the seas, which reveals a universal agency for enforcing economic pressure. "Absolute freedom of navigation upon the seas, outside territorial waters, alike in peace and in war," he declared to be one of our aims, with this pregnant qualification, "except as the seas may be closed in whole or in part by international action for the enforcement of international covenants."

This exception offers a wide range for the effective employment of economic pressure. The seas are the great highways of commerce. For centuries they were infested with pirates, corsairs, buccaneers, all manner of ocean bandits. Nations made common cause against them, but they were not swept from the seas until a century ago. Even then a form of legalized piracy, privateering, was sanctioned as a war measure and continued until a comparatively recent period. But all the time commerce was expanding and its claims for protection were being asserted. At the Paris Conference of 1856, Lord Clarendon agreed for Great Britain, then, as now, the greatest maritime power, in these four declarations:

(1) That privateering should be abolished.

(2) That a neutral flag covered enemy goods, except contraband.

(3) That neutral goods, except contraband, were not liable to capture unless under an enemy flag.

(4) That blockades to be binding must be made effective.

These declarations, although long unpopular with many influential men and interests in England, marked a great advance in the struggle for free commerce on a free ocean. They were international declarations, agreed upon at an international conference, and asserted the fundamental truth that the sea is an international highway, subject to international control.

But the United States did not adhere to the declarations as they did not concede the American contention that all private property should be exempt from capture by war ships, as well as by privateers, in maritime warfare. In the Hague Conference of 1899, Dr. Andrew D. White, head of the American delegation, endeavored to have this exemption of private property established, but it was decided that consideration of the question could not properly be given as the subject was not included in the official program announced when the conference was called. But when the second Hague Conference assembled in 1907 that omission had been fully corrected and at the first session of the Commission of the Conference, to which the question was referred, Joseph H. Choate, head of the American delegates, submitted this country's proposal, as follows:

"The private property of all citizens of the signatory powers, with the exception of contraband of war, shall be exempt on the sea from capture or seizure by either the armed vessels or the military forces of the said powers. Nevertheless, this provision does not at all imply the inviolability of vessels which should try to enter a port blockaded by the naval forces of the said powers, nor the inviolability of the cargoes of the said vessels."

Twenty-one nations supported the proposal, eleven opposed it, one failed to vote and eleven were absent. But among the nations opposed were Great Britain, France, Russia and Japan. Among the nations joining the United States in an affirmative vote were Germany, Austria-Hungary, Italy, Denmark, Holland, Belgium, Norway and Sweden. But no final decision was reached on the question. Mr. Choate said a year later, in an address before the New York State Bar Association, "It was not possible, in the face of the great commercial nations that opposed it, nations likely at any time to be engaged in war, to press the question further."

Now, under the stress of war, President Wilson has revised this American proposal. It still stipulates absolute freedom of the seas, but it carries the important amendment that the seas may be closed in whole or in part "by international action for the enforcement of international covenants." In fact, that is precisely what has occurred during this world war. The seas have been "closed in whole" to the commerce of Germany and the Central Powers through the international action of the nations of the Entente; and this action has been taken in order to enforce "international covenants" because of treaties broken and public law spurned by Germany and her allies. And the result has been economic pressure of the most drastic character. The ocean-borne commerce of the Central Nations has been not merely reduced but destroyed. Their ships are interned in hostile ports of all the seven seas. Even the lawless submarines, while damaging the commerce of their foe, have not helped their own. And these are all acts of war in a time of war. Manifestly should the freedom of the seas be abridged through the joint action of a league of nations, to enforce "international covenants" against a nation that had broken a covenant, the resulting economic pressure would be of overwhelming severity.

Napoleon's Decrees and the Submarine

When Napoleon was struggling for the mastery of Europe, in the early years of the nineteenth century, much as the Emperor of Germany has been struggling

for it during the early years of this century, he saw that his most determined and stubborn foe was England. And then, as now, the ocean-borne commerce of England, in relation to the commerce of the world, was tremendously large. Manifestly the way to strike hard against the island kingdom was to strike her commerce. Napoleon struck through an embargo and William II through the submarine. In the Berlin Decree of 1806 Napoleon declared a drastic prohibition against all trade with Great Britain. This was immediately answered from London by retaliatory Orders in Council forbidding trade with France. Napoleon, not to be outdone, promulgated his famous Milan decree, making lawful prize of all vessels submitting to British search or taxation. These decrees, for both England and France, were definite acts of war, and were so intended. But to a nation across the ocean, the young republic of the United States, they were also, in effect, acts of war, although this country was neutral

In 1807 the United States adopted an embargo in an endeavor to protect its foreign trade through compelling England and France to either make less restrictive or abolish altogether their repressive commercial policies. This purpose was declared by the Government when it proclaimed the embargo, which officially stated that it was believed that "by teaching foreign nations the value of America's foreign commerce and production, they will be inspired with a disposition to practice justice."

So one hundred and ten years ago this country undertook to apply economic pressure to accomplish an international purpose, that of justice. And looking back at the results, with the advantage of a perspective of over a century, it is entirely clear that we failed in our aim. Neither England nor France was forced through our action to change its drastic commercial policy. In fact, the chief sufferer was this country itself. Our foreign trade fell off from $108,300,000 to $22,400,000 in a single year. Channing, in making a survey of our endeavor to apply economic pressure, says in his "Jeffersonian System": "The Jefferson-Madison policy of war through commercial restriction had not worked well in practice. And when our Minister to England, William Pinkney, took up with George Canning, the British Prime Minister, the matter of lifting the embargo, he had to bear the biting but probably true statement that Canning would be glad to facilitate the removal of the embargo as a measure of inconvenient restriction upon the American people." There were other acts in the way of non-intercourse legislation, embargoes and endeavors at commercial reprisal adopted by this country both before and after 1807. But this one example is typical of all the others. So it can be presented as a historical precedent and the claim freely admitted that it does not prove the case for economic pressure. Nor, on the other hand, let it be definitely stated, does is disprove the case. It is only necessary to make the most hurried survey of the conditions surrounding the American embargo of 1807 to see that they were such that economic pressure could not possibly avail to accomplish the purpose this country had in mind.

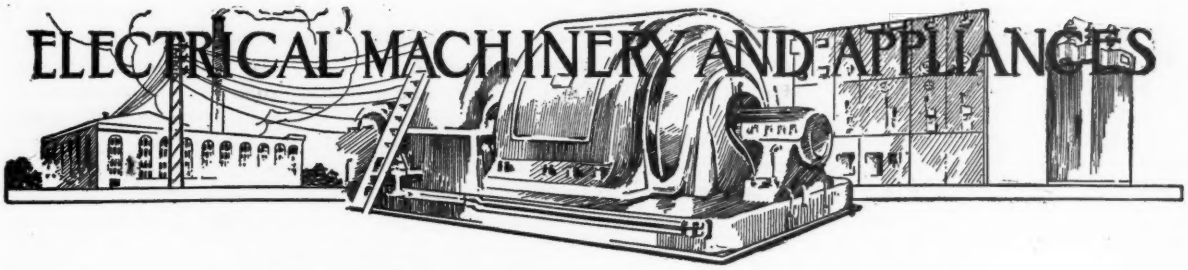
But this embargo of 1807 and other similar embargoes of the time failed to inspire other nations "with a disposition to practice justice" because it was not powerful enough. For the same reason Napoleon's Berlin and Milan decrees failed. And for the same reason the British Orders in Council failed. But these failures, by throwing into high relief the cause of failure, reveal the one sure ground on which economic pressure must be based in order to succeed. It must be strong enough to be effective, otherwise it is futile. And the whole case for economic pressure in the program of a league of nations is grounded on the fact that international economic pressure, applied by a league of nations, would be effective against any other nation, however strong that nation might be.

There is another manifest difference in the conditions surrounding economic pressure a century ago and those that would surround economic pressure now. Then instantaneous communication, the very spirit and heart of modern world organization, did not exist. It took many weeks to cross the ocean in sailing ships. Even on land there were no facilities, save the slow-moving coach, to bear mail pouches with their infrequent letters. Under the heavy handicap, which the archaic machinery of communication imposed, it is not improbable that these embargoes of a century ago would have failed, even if the United States had been at that time a nation of great commercial power and consequence.

There are two other historical examples, however, that may have some point and interest in the present discussion, although they cannot be said to present cases parallel with the one that will exist when a league of nations is constituted. When the great armada was being formed by Philip of Spain, the merchants and banks of Genoa were persuaded by the merchants of London to withhold credit and moneys from the Spanish King. This financial pressure was sufficient to delay the attack of the armada for over a year and by that time Sir Francis Drake and the captains of Elizabeth were ready to meet the shock. It would seem fair to say that what could be accomplished three centuries ago, against a nation as powerful as Spain then was, might certainly be accomplished against any nation today through the concerted application, not merely of financial pressure but of all forms of economic pressure through a concert of nations in a league.

Another example that may bear some information of service belongs to the present century and to so recent a warlike incident as the dispatch by the German Emperor of the gun-boat to Agadir, thus bringing on the acute crisis with France with the imminent probability of general war throughout Europe. While that crisis was at its height, I chanced to be in Paris and was having luncheon one day with a young French banker of the Credit Lyonnais. I remarked on the fact that the crisis seemed to be a trifle less acute and inquired the reason. "We are withdrawing our French investments from Germany," was the rejoinder, "and that economic pressure is relieving the situation."

In each of these cases, it should be noted, financial pressure was being applied against a single nation by another single nation. But even so, the result strongly supports the view that when this force is applied by a group of nations against a single nation pressure would prove to be irresistible.



Electric Storage Batteries---III

Charging

When employed in connection with large light and power systems, storage batteries are generally maintained as "standby" units being kept "floating" on the line, charging when the load becomes comparatively light and discharging when the demand for current becomes such as would otherwise overtax the capacity of the generating units. Under such conditions, the discharge may exceed the charge and as a result it frequently becomes necessary to give the battery an extra charge. The voltage of the charging source must always be greater than the battery discharge voltage and the charging current must always flow through the battery from the positive pole to the negative pole.

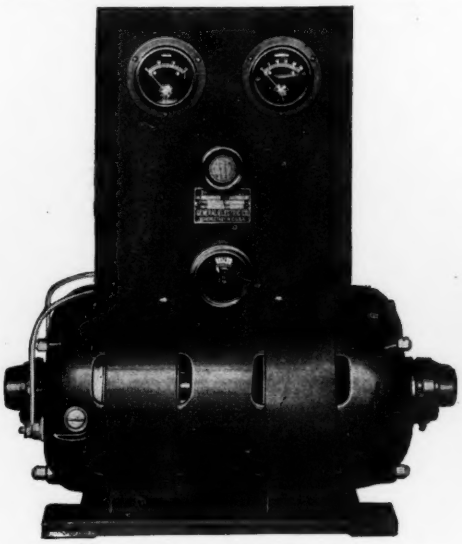


FIG. 22. GENERAL ELECTRIC BATTERY CHARGING SET

In charging small batteries the most serious obstacle encountered is the difference between the voltage of the supply ordinarily available for this purpose and the voltage at which the charging is to be done. And when only alternating current is available, motor generators, rotary, mercury or some other form of converter must be employed to change this to direct current. A very compact outfit designed and marketed by the General Electric Co. for this purpose is the combined motor generator set and control board shown in Fig. 22. The alternating current end is wound for the voltage available on the supply lines, while the direct current voltage depends upon the maximum number of cells to be charged at any one time. By means of the rheostat mounted on the control panel, the direct current voltage may be reduced in value to 25 per cent of the rated voltage of the outfit.

One of the latest developments in the field of battery charging equipments is the Tungar rectifier, also a product of the General Electric Co. This converter, as shown in Figs. 23 and 24, will charge from one to ten 3-cell starting and lighting batteries at a 6-amp. or lower rate and consists essentially of a bulb similar in appearance to an incandescent lamp, a compensator and a rectifier all contained within a metal casing, the front of which is fitted with a panel carrying the necessary control, measuring and regulating equipment.

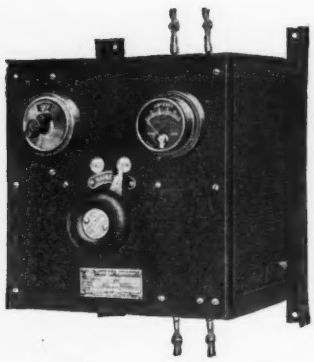


FIG. 23. THE TUNGAR RECTIFIER

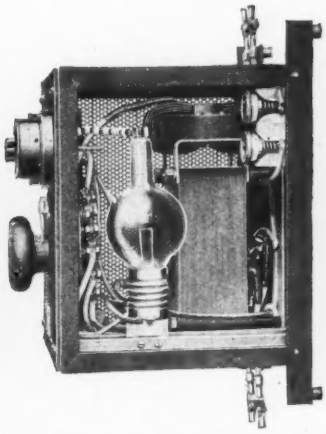


FIG. 24. SIDE VIEW OF TUNGAR RECTIFIER

The bulb contains Argon, and, as may be seen by referring to Fig. 24, has in addition to a low-voltage filament, a third terminal, the anode. The combination of the heated filament and the gas makes it possible for current to flow in but one direction, from anode to cathode and as a consequence only uni-directional or direct current can be delivered by the rectifier. The compensator and re-actance are for the proper adjustment of the alternating current and voltage.

Connections for a 6-amp., 75-v. Tungar rectifier and batteries are shown in Fig. 25.

In the Breco Converter manufactured by the Breco Electric Co., a graphite valve used in connection with a commutator and an electrical timing device is employed to permit current to flow in but one direction. As in

the case of the Tungar rectifier, failure of the alternating current supply results in a positive disconnection of the device from the alternating current lines, while charging is again automatically started with the return of the supply current.

Another device in extensive use for the charging of small storage batteries is the mercury arc rectifier, of which an elemntary diagram of connections is shown in Fig. 26. The essential parts of this device are the rectifier tube, an exhausted glass vessel in which are two graphite electrodes (anodes AA′) and one mercury cathode B; the main re-actance and the panel.

Each anode is connected to a separate side of the alternating current supply and also through one-half of the main re-actance to the negative side of the battery load. The cathode is connected to the positive side. There is also a small starting electrode C, connected to one side of the alternating-current circuit through resistance and used for starting the arc. When the rectifier tube is rocked, so as to form and break a mercury bridge between cathode B and starting anode C, a slight arc is formed. This starts what is known as the "excitation" of the tube and the cathode begins supplying ionized mercury vapor. This condition of excitation can be kept up only as long as there is current flowing toward the cathode.

If the direction of supply voltage is reversed so that the formerly negative electrode or cathode becomes positive, the current ceases to flow, since in order to flow in the opposite direction it would require the formation of a new cathode, which can be accomplished only by special means. Therefore, in the rectifier tube the current must always flow toward the cathode which is kept in a state of excitation by the current itself.

Such a tube would cease to operate on alternating current voltage after the elapse of one-half cycle if some means were not provided to maintain the flow of current continuously toward the cathode. This is accomplished by the main re-actance. As the current alternates, first one anode and then the other becomes positive, the current flowing from the positive anode through the mercury vapor, toward the cathode, thence through the battery, or other load and back through one-half of the main re-actance to the opposite side of the alternating current supply circuit. As the current flows through the main re-actance it charges it and while the value of the alternating wave is decreasing, reversing and increasing, the re-actance discharges, thus maintaining the arc until the voltage reaches the value required to maintain the current against the counter electromotive force of the load and reducing the fluctuations in the direct current. In this way a true continuous current is produced with but little loss in transformation.

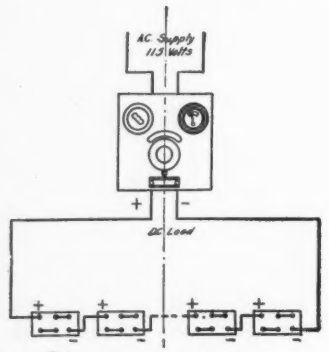


FIG. 25. CONNECTIONS FOR BATTERIES AND 6-AMP., 75-V. TUNGAR RECTIFIER

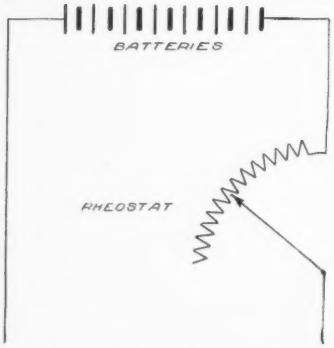


FIG. 27. BATTERY UNDER RHEOSTATIC CONTROL

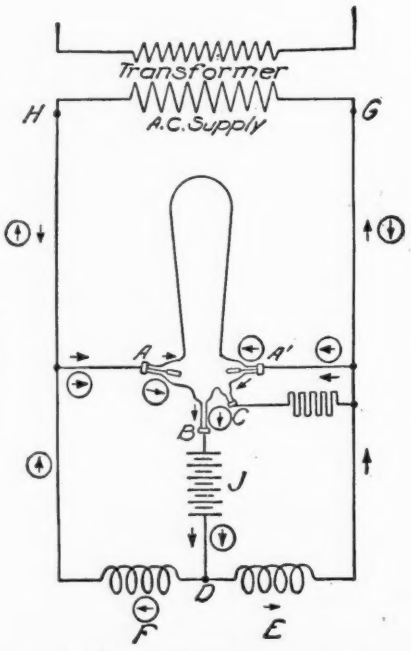


FIG. 26. ELEMENTARY DIAGRAM OF CONNECTIONS OF G. E. MERCURY ARC RECTIFIER

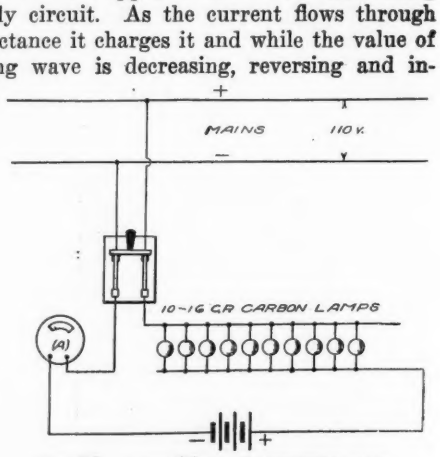


FIG. 28. TEN 16-CANDLEPOWER CARBON LAMPS CONNECTED IN THIS MANNER WILL PROVIDE A CURRENT OF 5 AMP.

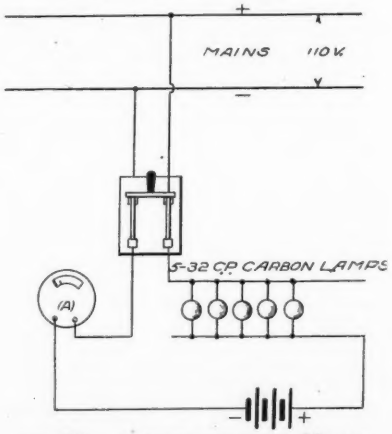


FIG. 29. CONNECTING FIVE 32-CANDLEPOWER CARBON LAMPS IN THIS WAY WILL ALSO GIVE A 5-AMP. FLOW

To get an idea of the operation of the mercury arc rectifier assume the instant when terminal H of the supply transformer is positive; anode A is then positive and the arc is free to flow between A and B. Following the direction of the arrow the current passes through battery J, one-half of the main re-actance coil, E, and back to negative terminal G of the transformer. When the impressed electromotive force falls below a value sufficient to maintain the arc against the counter electromotive force of the arc and load, reactance E, which heretofore has been charging, now discharges with the current, however, in the same direction as before. This serves to maintain the arc until the counter electromotive force of the supply has passed through zero, reversed and built up to such a value as to cause anode A to have a sufficient positive value to start the arc between it and cathode B. The discharge circuit of re-actance coil E is now through arc AB instead of through its former circuit. Consequently, arc AB is supplied with current, partly from the transformer and partly from re-actance coil E. The new circuit from the

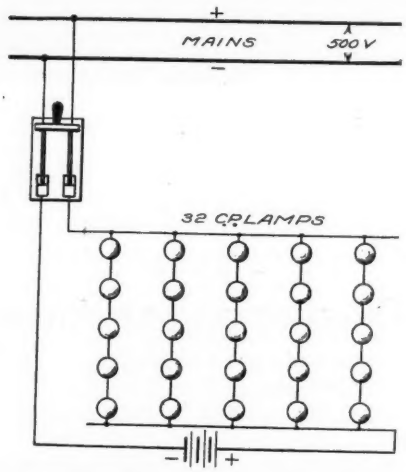


FIG. 30. METHOD OF CHARGING FROM A 500-V. CIRCUIT

transformer is indicated by the arrows enclosed in circles.

Where direct current is available but at a voltage in excess of that required, batteries may be charged by connecting them in series with carbon filament lamps, resistance units or rheostats. A 110-v., 16-candlepower carbon filament lamp has a resistance of approximately 220 ohms and will, therefore, provide a current flow of about 0.5 amp. and a 32-candlepower lamp of like voltage rating but with a resistance of 110 ohms will allow the passage of about 1 amp. of current. If, therefore, a charging current of 5 amp. is desired, this may be obtained by means of the connections shown in Fig. 28, using ten 16-candlepower lamps, or by means of the connections shown in Fig. 29, using five 32-candlepower lamps.

Should the direct current supply be at a voltage of 500, a 5-amp. current flow may be secured by connecting in parallel, five sets or "banks" of 32-candlepower lamps, each set consisting of five lamps in series. See Fig. 30.

A scheme of connections providing somewhat more capacity and a greater degree of flexibility is shown in Fig. 31. In combination with a 25-amp. combined switch and plug cutout, a 0 to 25-amp. ammeter and the necessary snap switches, 30 ordinary lamp sockets, each carrying a 110-v., 32- candlepower lamp, are mounted on a board and connected in groups of 2, 4, 8 and 16, respectively, and as the lamps are in series with the batteries,

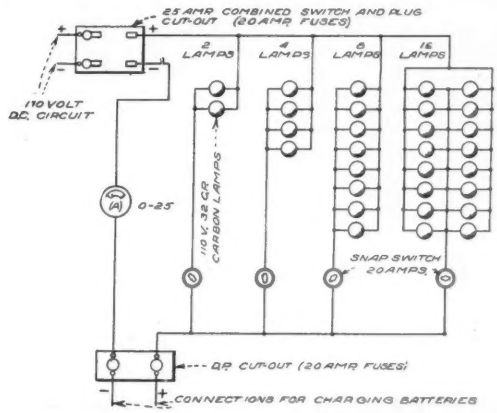


FIG. 31. DIAGRAM OF CONNECTIONS PROVIDING GREATER FLEXIBILITY AND RANGE OF CHARGING CURRENTS

it is possible to regulate the current flow by manipulation of the proper snap switches. With this arrangement from one to twelve 3-cell batteries can be connected in series and charged simultaneously, care being taken, however, that the positive terminal of one is connected to the negative terminal of the next, and so on.

For "trickle" charging, that is where a number of batteries are held in wet storage, the scheme of connections recommended by the Electric Storage Battery Co. and as shown in Fig. 32, may be used. Connect no more than fifteen 3-cell batteries in series across a 110-v. direct current circuit and charge continuously. For from 1 to 10 batteries use a 25-w. lamp and for from 11 to 15 batteries, a 40-w. lamp.

Before going on trickle charge and at intervals during the charge, the filling plugs should be removed and water added as required. Soon after starting the charge, take a gravity reading of each cell and follow this at

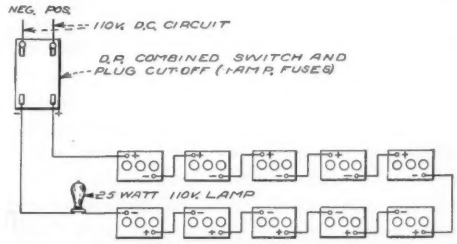


FIG. 32. CONNECTIONS FOR "TRICKLE" CHARGING

frequent periods to the end to determine whether all cells are in good condition.

Notes on Alternator Windings

By Gordon Fox

THE stator winding of a revolving field alternator may be of the distributed type, having groups of several coils per phase per pole or windings having but one coil per phase per pole may be employed. Single

coil windings are the cheaper to build. They also have the advantage of producing a higher terminal voltage with a given number of turns, since the voltages in all the conductors of a phase are in phase (with a full pitch winding). On account of comparatively large inductance, single coil windings lead to poor voltage regulation and heavy excitation is required to maintain the voltage under load, particularly if the power factor of the load is low.

Alternators having distributed windings are better suited for power plants feeding long distance transmission systems, since their voltage regulation is better. The shape of the generated wave form depends partly upon the distribution of the windings. A distributed winding produces a close approximation to a sine wave of voltage. There is less likelihood of dangerous voltage rises through effect of resonance on account of the capacity of the transmission line, this danger being more pronounced with the peaked wave form of voltage.

The Blind Taping Coils

LAST FALL, the question of securing some help from the blind was taken up by the Westinghouse Electric & Mfg. Co. with the Pennsylvania Association, a branch of which is located in Pittsburgh, and a sample lot of motor coils to be taped was sent to the association in order that the employes might be given a chance to show what they could do. When the coils were returned, it was very evident that this work could be done in an entirely satisfactory manner by those who have been deprived of their sight. Accordingly, arrangements were made with the management of the association to allow some of their employes to do this work, payment to be made on a piece work basis.

As this was an entirely new line of work for them, it was decided to have a representative of the association go to East Pittsburgh to become familiar with the work so as to be in a position to instruct those assigned to do the work. The representative selected for this training was the wife of a former Westinghouse employe, who was deprived of his sight last summer and who is now employed at the association. She went to East Pittsburgh and was employed until such time as the management felt that she was sufficiently proficient in the taping of coils to teach the blind and to inspect their work.

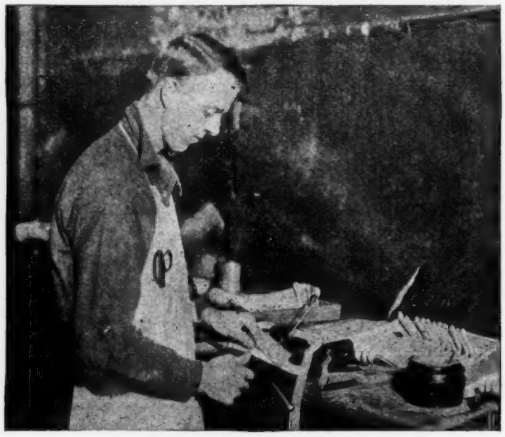
At the present time, seven persons are employed and their efforts have been very satisfactory, insofar as quality is concerned. Naturally, as this is new work, the speed is not so great as with those who can see; but this will increase as they become more proficient, and also the number employed will be very materially increased.

In order that they may not suffer any loss of revenue, while learning this new work, the association is paying them the difference between what they earned at their former employment and what their present production would entitle them to receive.

One of the employes engaged in this work, shown in the accompanying photograph is Carrol Moore, formerly an employe of the Westinghouse Co., deprived of his sight, because of his previous familiarity with electrical apparatus finds it easy to adapt himself to taping coils.

In addition to the new venture of coil taping, the association also operates a broom making department, a woman's department, formerly engaged in chair caning, which has now been abandoned in favor of coil taping.

The women's department is engaged in weaving rag carpets, Red Cross aprons, dresses and various kinds of women's and children's wearing apparel.



BLIND WORKMAN TAPING COILS

Some idea of the broad scope of the organization may be obtained from the fact that last year the sales from the products of the blind employes amounted to over $40,000.

A Question and an Answer

MANY OF US IN the great army of stay-at-homes chafe over our inaction during the war time and ask, "How can I help?" The editor of the Brooklyn Eagle gives this answer:

"Those who regard the sale of War Savings Stamps as a side enterprise or as something that appeals mainly to children totally miss the purpose behind a plan which is one of the best thus far evolved for war purposes. In the last analysis the selling of these Stamps is the fitting of the whole Nation to sustain the burden of the war. It is the application to war finance of the principle of universal service. It aims to enlist all of the American people in direct support of that gallant minority among them who have answered the call to arms and prepared themselves for the firing line.

"The War Savings Stamps supply the final and conclusive answer to the question: "How can we all help?"

A MAN IN England wishes to secure agency for the sale of electrical material, including wiring, sockets, fuses, lamps, switches, etc.; quotations to be made f.o.b. New York, and payment cash against bill of lading. Further particulars may be had by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., mentioning No. 27,093.

OUR MEN in the trenches and in the submarine chasers are doing their part. Are you doing your part? Buy War Savings Stamps to your utmost capacity.

Power Plants and the Fuel Administration Situation

OFFICIAL AND AUTHORITATIVE INFORMATION ON THE COAL, POWER AND HEATING SITUATION AND REGULATIONS OF THE FUEL ADMINISTRATION DURING WAR-TIME. BY A. P. CONNOR*

READERS WILL REMEMBER, feelingly what took place during the past winter in connection with the coal supply, and how they felt then that they "wished they had known ahead of time that the Fuel Administrator was to act as radically as his orders indicated." A little information or warning ahead is of great service, and the writer feels that it is unnecessary to emphasize to the readers of Power Plant Engineering the need of taking precautions NOW to get their plants into shape to meet the possible conditions that may come during the next few months. If we know what our conditions are, and what conditions the Fuel Administration will impose upon us, we shall be in a position to adapt our actions accordingly. So little of detailed authoritative statements have appeared that it is desirable to give many details in Power Plant Engineering, in order to correct in a measure hazy impressions on the subject of coal and its supply during these times of stress. Besides, new and unusual circumstances have arisen, and many new and varied conditions have to be met. All these matters require careful consideration, may require special action on the part of the reader to meet the requirements of the Fuel Administration, or may need appeal to the Fuel Administration to ameliorate its requirements for the reader and the interests that he represents.

The Fuel Administration, following principally the requirements of the war, attempts to adjust efficiently all fuel matters to its proper conduct, with, at the same time, a benevolent consideration for the general welfare of the people of the country. These requirements mean continual adjustments, generally enforced by orders or suggestions from the Fuel Administration, and mainly on lines that are practical and opposed to the freakish and inefficient customs that pertained in many instances to fuel supply and use before the war period.

Thus the power user who seeks to obtain the coal for a power plant from a coal mine a thousand miles away, when there is an available supply within a hundred miles, will find that he will have the Fuel Administration to cope with and a resulting abridgment in his freedom of action to buy coal where he pleases. But by an intelligent co-operation with the principles of the Coal Administration no great inconvenience will be caused, although in some instances it may lead to an entire suspension of some power plants and considerable local inconvenience. In such cases the trouble resulting will be necessary in order to conserve the greater safety and convenience of the nation and country.

Co-operation of every unit connected with the use of fuel is urgent, extending from the fireman stoking the boilers to the ultimate use in form of power or heat at the consumer's apparatus. This co-operation depends on two great elements, that of individual effort and that of co-operative effort, both of which are outlined in the scope of the Fuel Administration's work. Thus it is the duty of everyone interested in the use of coal to obtain the greatest result from it to the very last use of its power and heat, in perfect teamwork with the orders of the Fuel Administration, which teamwork is entirely dependent on the proper reading and understanding of the information emanating from the Fuel Administration of the United States.

DR. H. A. GARFIELD, FUEL ADMINISTRATOR

DIVISIONS OF THE SUBJECT

IN GENERAL, the subject of the coal situation, as it appeals to the readers of this magazine, divides itself up into the following phases:

1. The use of coal for power.
2. The use of coal for heating.
3. The use of coal for power and heating, as in exhaust heating systems.
4. The supply of coal, as, for instance, the amount that may be stored by individual plants, the amount that will be apportioned from a large common storage for individual users during the season; the amounts

*Washington Correspondent for Power Plant Engineering.

In order to meet the problems arising in connection with the regulations and fuel supply conditions established by the Fuel Administration, Power Plant Engineering has arranged to keep directly in touch with the various departments of the Government in Washington, that have this duty and work within their jurisdiction, so that our subscribers and readers will have the fullest and most authoritative information on the subject as soon as it is available and in form to be acted upon. A. P. Connor, the writer of these articles, is known to our readers from articles he has written in this mazagine from time to time, is a lawyer as well as an electrical and mechanical engineer, and is well qualified to go into the various details that arise in connection with this subject at this time. Power Plant Engineering considers it a duty to help its readers to the utmost in connection with this item of fuel, so vital to the interests of all, and will be glad to assist by answering any general questions on the subject of particular value and interest, in these columns, on request.

that may be obtained during the season on the order of individual power plants; where coal supply may be ordered from; what discrimination may be used in the supply of coal for power plants for different industries; what fuel may be used, and other important phases affecting the fuel supply.

5. The regulations promulgated for the attention of power plants.

6. The records and official reports that the Fuel Administration will require from power plants and coal users.

7. The system of inspection of power plants by the Fuel Administration.

8. The manner of distributing charges for power and for heating separately.

9. The adjustment of prices, costs and wages and returns.

10. The relation of the user of the product of the power plant to the producer of the product.

11. The sources of official and authoritative information.

12. The systems established in and by the Fuel Administration and throughout the country.

13. Miscellaneous phases.

It is well to appreciate the fact that the purpose of the Fuel Administration is to take care of the requirements of the war, FIRST, the people and other interests following. No power plant is so big at this time as to be above the manipulation of the Fuel Administration in any way that it deems fit for the promotion of the war and its aims, and complaint as to any radical action on the part of the Fuel Administration in any individual case has none of the force that would support it in normal or peace times. Thus the reader should be prepared for anything that may turn up in his individual case, and accept his hardships with the patriotic endurance of the soldier on the battlefield, who risks everything for his country and gladly suffers the calamities incident to his duty and the needs of the war.

The practical aspect of the matter deals with the necessity of increasing the efficiency of every part of power plant practice, and in order that the manner of doing so may be definite and uniform it must follow the leadership of duly established and competent authority, which in the present case is the Fuel Administration. The liberty left to the individual power plant is, however, unlimited in the direction of increase in efficiency, and every encouragement is extended to the elimination of every slacker leak that may exist. On the road of inefficiency stands the Fuel Administrator, ready to deter those that use it and start them in the proper direction, whether they are willing or not.

The Fuel Administration

Shortly after the United States entered the war there came about confusion of fuel conditions, particularly in connection with the supply and delivery of coal, throughout the country. President Wilson, by a series of executive actions, endeavored to reduce the difficulties in the situation until the necessity of the case required extensive treatment. The result was that on Aug. 23, 1917, he established a new governmental department, designated as the United States Fuel Administration, and announced the appointment of Dr. Harry A. Garfield as its head. Dr. Garfield at that time was president of Williams College. He is a lawyer, a practical coal man and has successfully managed, reorganized and constructed a number of large enterprises, particularly in the state of Ohio, and is ex-president of the Cleveland Chamber of Commerce. Personally, Dr. Garfield is impressive. He is a man who appeals strongly to the individual as a leader of men, and as a man to accomplish objects desired in the most thorough and tactful way. He is practical and tempers his line of action and judgment with a full consideration of the human side of the question. He is entirely free from bureaucratic severity that sometimes enters into the machinery of governmental work, but on the other hand he is gifted with a spirit that appears to create, spontaneously, constructive action and co-operation, and has always shown himself sensible to all intelligent suggestion looking towards the improvement of the fuel situation.

After the creation of the department there was established throughout the country a system of fuel administration, controlling the coal situation through the United States. This body is under the direct supervision of the Fuel Administrator and his offices in Washington. Under this main body follow the fuel administrators appointed in the various states to adjust local affairs in fuel administration, and these latter are assisted by county or more local administrators or committees. The central or head body acts like a main clearing house and judicially guides the flow of fuel to its proper channnels without conflicting currents, particularly between state interests. It has entirely revised the system of coal distribution throughout the country. It has protected all interests against excessive price difficulties. It has conserved the coal supply to an appreciable extent. It has prevented unnecessary labor difficulties, and, above all, it has saved the country from an humiliating breakdown in the fuel supply, which might have resulted in serious consequences.

This department is now evolving progressively a system of fuel efficiency having for its object a systemized improvement of every channel where fuel is used. It is going about the matter intelligently, creating new agencies as they are required, but in every instance making active use of all available and existing facilities for the purpose. The whole system of the Fuel Administration has appeared to be based on the principle: "Use every available practical and constructive facility that will improve the fuel situation, and give immediate and intelligent consideration to all spontaneous or volunteer efforts extended from accredited sources." It is advisable for each power plant to get acquainted with the fuel administration in its district, where it is located, what local regulations or arrangements it has instituted or provided, and such other information as may prove of value in a case of necessity.

Who Is Interested?

Everyone is an "interested party" in this subject, the readers of Power Plant Engineering especially, for their duties will be more or less controlled by the Fuel Administration. They will find that their duties and responsibilities are increased, in that they will be expected to secure a greater degree of efficiency in every detail in their plants. It will be no reflection on a power plant to have its inefficiencies listed, but it will be a

reflection if, after such listing, no action is taken on the part of those interested in it, to improve the efficiency. The system of the Fuel Administration will be such as to place the responsibility for improvement of a power plant on the party who merits it. Thus the Chief Engineer will not be burdened with the blame, when the action desired depends on the owner's going to some expense to remove obsolete apparatus and install more up to date. The material point in the matter, and the most valuable suggestion that can be made, is that each party investigate his plant from the bottom up, and be ready to improve the details and remove the leaks before the inspector "walks in." What leaks or inefficiencies are to be looked for will depend on the power plant and the conditions, and while some suggestions may be offered in this matter in a later section, it is substantially up to the party in charge to find out what are the specific requirements in his own plant.

Procuring Coal

A power plant must procure its coal before it can use it, and the question of how to get the coal will be taken up first.

The Fuel Administration has upset the old order of things in the matter of coal supply by limiting the power plants in the various sections of the country to the use of a coal supply which it designates. Its discretion in the matter is supreme, and it therefore behooves each power plant to find out exactly where its supply is what kind of fuel it is, and what are the best arrangements to be made in the matter. (See May 15 issue, page 402.)

The Director of Railroads is concerned in this problem, and acts in co-operation with the Fuel Administration, and it is therefore practically impossible for a power plant to get fuel other than from the sources designated by the Fuel Administrator for its district. The general principle of these two governmental departments is to get the coal for a user from as close a mine as possible.

Prices of coal are fixed by the Fuel Administrator, as given in May 15 issue, page 405, and these are based on sworn information obtained from the mining companies, and after due investigation. The method of arriving at the costs of mining are standardized as much as possible, and then with due consideration for local conditions existing, the retail prices are made or confirmed.

Coal Control

State Administrators are appointed by the Fuel Administrator of the United States and confirmed by the President, and have charge of the administrative work in each locality. They are, in turn, assisted by local or county administrators. As a further adjunct to the system, there are established in each coal producing district representatives whose duties are to see that the regulations of the Fuel Administrator are carried out. There is also established a zone system of distribution arranged to economize the hauling on railroads and relieve the stresses on transportation facilities caused by the large expansion of war industry. Shipment of coal for the bunkering of ships is restricted to certain high grades, and a clean coal order, which is being rigidly enforced, has been put into effect to eliminate the transportation and handling of fuel not up to the standard.

Anthracite for industrial uses has been deliberately limited, and it is forbidden to move it in certain areas, in order to avoid any extra tax on an already overburdened transportation system. The Fuel Administration is encouraging production by urging an early ordering of coal for domestic purposes. All power plants throughout the country will be inspected and will be given a rating depending on their efficiency. A preliminary estimate has indicated that upwards of 50,000,000 tons of coal may be saved annually to the country by correct operation without undue waste.

The railroads are being given special attention, and the importance of this may be appreciated since they consume one-third of the entire bituminous production of the United States.

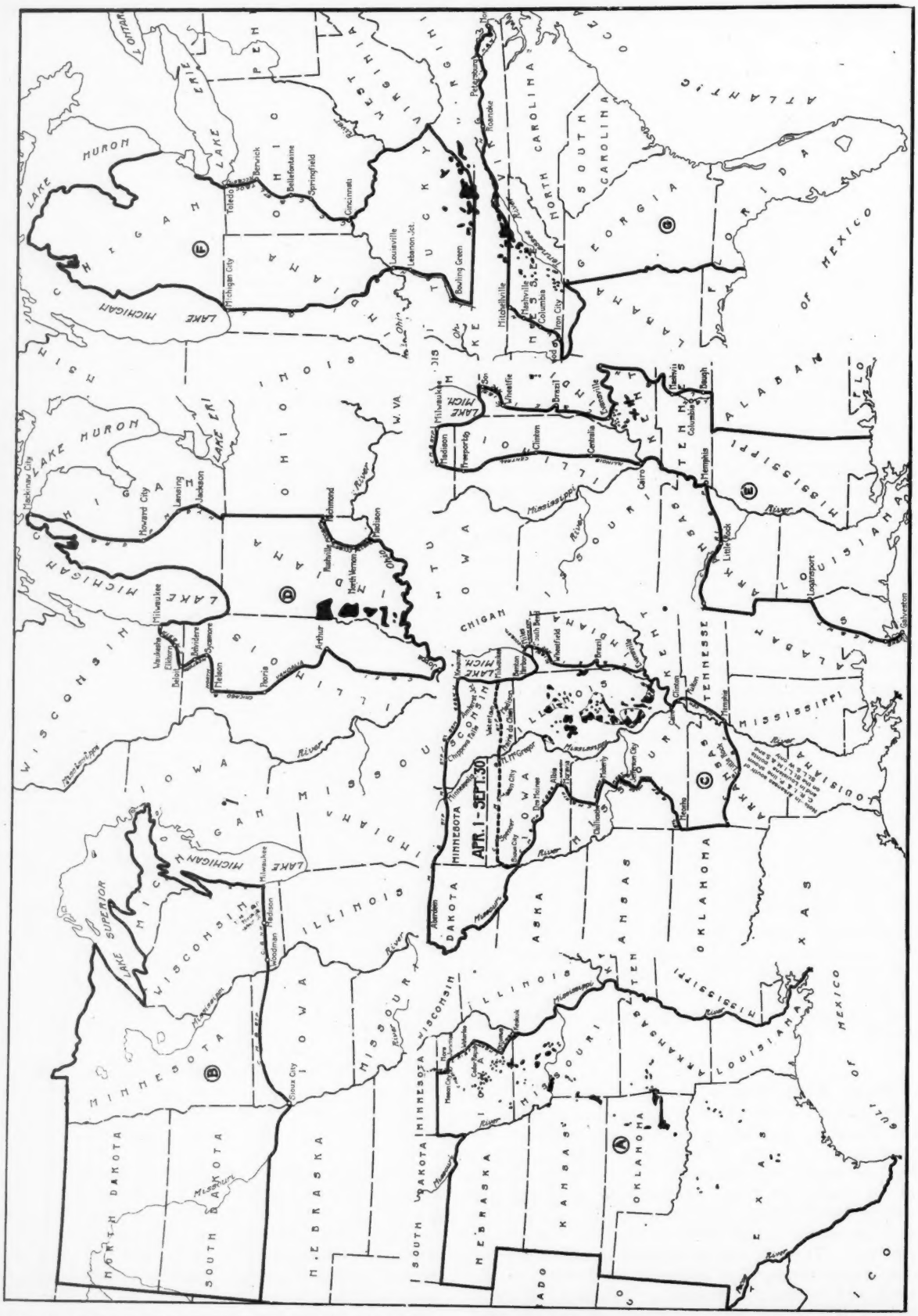
The use of coal in every possible place is within the investigation of the Fuel Administration, and is by no means limited to power plants; office buildings, apartment houses, hotels and other large users of fuel are being placed under severe scrutiny and may expect special action, in view of the fact that their use of coal is considered wasteful in many cases.

Zone Distribution

The zone is, in general, a certain coal area surrounded by certain states and railroad facilities which are logically situated to use the coal from this area. The zone system applies only to coal supplied by railroad; it does not interfere with coal transported by water privately; in fact, the latter is encouraged. It does not interfere with the use of special coals usable in the arts for certain results which are not obtainable with ordinary coal; but in the case of the special coals, special permits have to be obtained from the Fuel Administration before they can be transported and used. Coal for Canada is subject to special regulation of the Fuel Administration.

The Fuel Administration encourages the storage of coal during the summer months, and power plants should do what they can in the matter in conformity with the Fuel Administration rules. Attention is called to the fact that certain zones change in their scope in the winter months from the scope of the summer months. At the present time there appears to be no need for curtailing the amount that can be acquired by a power plant, and those with storage facilities should make the most of them, for the prospect of seriously curtailing the supply of coal during the winter months is great.

Those power plants with limited storage facilities would do well to consider their needs and provide storage of some kind, or get into immediate touch with their local coal administrators about the matter, appreciating, however, that coal in the hand in storage is worth a million times the amount in promised arrangements during this war period. Those who delay attention to the matter take the most serious chances, especially after the hint of the Fuel Administration to take



Zone A, limits of supply from producing districts of Missouri, Arkansas, Kansas, Oklahoma and Iowa.

Zone B, limits of supply from Lake Michigan and Lake Superior coal docks.

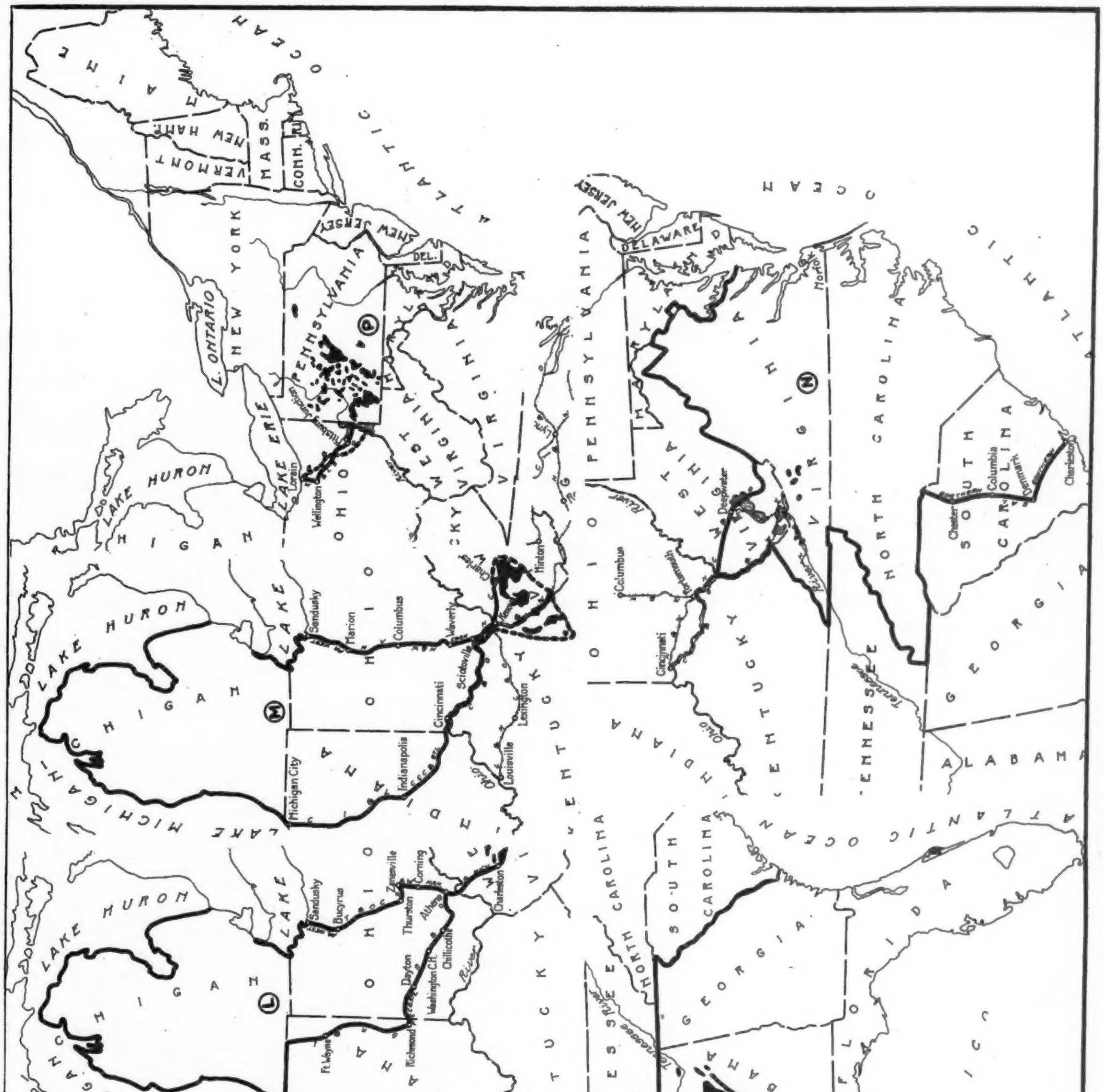
Zone C, limits of supply from Illinois producing districts, for summer by full line; from Sept. 30 to April 1, northern limit is dotted line.

Zone D, limits of supply from Indiana producing districts.

Zone E, limits of supply from western Kentucky producing districts on the I. C., L. & N. and L. H. & St. L. railroads.

Zone F, limits of supply from mines on the L. & N. R. R. in Virginia, eastern Kentucky producing districts on the L. & N. and C. N. O. & T. P. railroads and mines in Tennessee on the Cumberland Valley Division of the L. & N. R. R. and the Middlesborough R. R.

Zone G, limits of supply from Tennessee and Georgia producing districts; Kentucky mines on the L. & N. R. R. main line and branches at and south of Corbin, on the C. N. O. & T. P. Ry. south of Somerset; southern Virginia districts, including Black Mountain and Stonegay in Lee, Wise and western Russel counties located on the L. & N., Va. & S. Wn., Interstate, N. & W. and C. C. & O. Railroads.



Zone H, limits of supply from Alabama producing districts.

Zone K, limits of supply from Ohio producing districts.

Zone L, limits of supply from West Virginia high volatile fields, mines on the K. & M., K. & W. Va. and C. & C. (west of Dundon) Railroads.

Zone M, limits of supply from high volatile fields of West Virginia and Kentucky, mines on the W. Va. & Ky., in the Thacker-Kenova and Kanawha districts on the N. & W. and C. & O. Railroads and eastern Kentucky lines on the C. & O., the S. V. & E. and N. & W. Railroads.

Zone N, limits of supply from low volatile fields of West Virginia and Virginia, mines in Pocahontas, Tug River and New River districts on the N. & W., C. & O. and Virginian Railroads. Also mines in the high volatile Clinch Valley district, in Tazewell and eastern Russell counties along the N. & W. and Virginian Railroads.

Zone P, all mines in northern West Virginia, Pennsylvania and Maryland on the B. & O., Wn. Md. and Coal & Coke Railroads, east of Dundon, and all mines north of those lines can ship eastward to all points in West Va., Md., D. C., Del., Pa., N. J., N. Y. and the New England states, including coal for transshipment on vessels at tidewater. They can ship westward only to Lake Erie ports for lake vessel transshipment; but Pennsylvania producing districts can ship as far west in Ohio as the lines of P. & W. V. and W. & L. E. Railroads, as shown by the full line; and the Pan Handle West Virginia districts in Brooke, Marshall, Hancock and Ohio counties can ship west to the line of the B. & O. R. R., C. L. & W. branch, Bridgeport to Lorain, as shown by the dotted lines.

care of their needs during the summer months if they can.

The reason for the encouragement by the Fuel Administration of the acquiring of coal during the summer months is twofold. First, the railroads can operate more easily in summer, and, secondly, the buying of coal at this time enables the mines to be kept busy and make the distribution of coal more uniform than if left to the beginning of winter, with its consequent peak effect on the coal mines and the railroads.

A brief outline of the zone system as at present established is as shown in the illustrations.

The Fuel Outlook

SOME OF THE DATA AND IDEAS PRESENTED AT THE RECENT MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS AT WORCESTER, MASS.

THE meeting was notable as being one of the largest ever held outside of New York City, and as being almost wholly devoted to subjects that had to do with war activity. Such topics as Munitions Manufacture, Fire Protection to avoid delay of production, Safety Provisions to prevent curtailing man power, Vocational Training, largely as to fitting of men for war industries and special training for crippled soldiers, and Housing of Workmen to insure content and high working efficiency were among those given chief consideration and discussion.

Visits to plants doing war work were arranged; also a trip to Camp Deven at Ayer, Mass., where members gained a clearer idea of the work that is being done in training our National Army, including infantry work in trench warfare, engineer preparation of defense, roads and bridges, artillery fire, and quartermasters and ordnance work for provisioning and equipping the troops.

Of special interest to power plant men was the discussion at the First Session, an abstract of which follows:

At the general session, Dr. Ira N. Hollis mentioned that in New England alone the fuel shortage for the year would be 6,000,000 tons. Co-operation of every man is needed in helping to fight this war, which is being waged for the continuance of the principles of the Ten Commandments as a moral standard for the world, in place of the principle that immoral brute strength gives the right to dominate and govern. He mentioned that 50 per cent of our industries are now engaged in work that will help to win the war. These must be supplied, and will have fuel to meet their needs. No others will get fuel until all war work is served. One plant was cited where a study of the use of power showed that 40 per cent could be saved by improved methods of transmission and use, and a committee of workmen is now serving as a patriotic duty in finding new methods of eliminating waste of power in that plant.

Topics suggested for discussion at the Fuel Session were:

1. What Are the Economic Effects of Impurities in Coal?

   Incombustible in fuel has a detrimental effect upon furnace operation out of all proportion to the percentage of refuse contained. It has been claimed that when coal contains 40 per cent of refuse it becomes valueless as fuel.
2. To What Extent Is Fuel Oil Likely to Be Used as a Substitute for Coal?
4. What Are the Possibilities in the Direction of the Utilization of Anthracite Wastes?

   What success have you had in burning anthracite slack or culm? Do you mix it with soft coal and in what proportions? What sort of grate do you use and what is your practice with regard to thickness of fire, draft, rate of combustion? Can the mixture be burned in a stoker?
5. What Instruments Are Useful and Desirable in the Boiler Room as Aids in Saving Coal?

   What class of equipment has been of the most value to you and how?
6. What Is Essential to the Economical Operation of Hand-Fired Boiler Furnaces When Using Soft Coal?
7. To What Kinds of Plants and Coals Are the Different Types of Mechanical Stokers Respectively Adapted, and What Is the Limiting Factor to Their Use in the Small Plant?

   Can we agree upon the type of fuel to the combustion of which each type of stoker is best adapted? How large must a plant be to warrant the use of a mechanical stoker?
8. What Experience Have You Had in the Use of Wood as Fuel? To What Extent Is Wood Available as a Fuel?
9. What Coal Economies Can Be Effected in Residence Heating?
10. What Coal Economies Can Be Effected in the Small Steam Plants?

    In plants which are not sufficiently important departments of their industries to warrant expert supervision, what are the principal sources and methods of waste and how ean they be avoided and corrected?
11. What Experiences Have You Had With the Storage of Coal?

GOVERNMENT PLAN

THE GOVERNMENT PLAN for fuel conservation was outlined by David Moffat Myers, Advisory Engineer of the Fuel Administration; the points given in the article on p. 473 of the issue of June 1 were discussed. In each coal-using state an Administrative Engineer will be appointed, with a staff of assistants, a force of inspectors, and a consulting board. The fundamentals of action are as stated in the article referred to, and have been endorsed by states which represent 70 per cent of the fuel used, outside of railroads, in the country. The plan is now in operation in Pennsylvania and Connecticut and will be started in other states as fast as the organizations can be perfected. Thomas R. Brown is administrative engineer for western Pennsylvania, W. R. C. Corson for Connecticut and Edward N. Trump for New York. Other states where the organization is under way are

Massachusetts, New Jersey, Illinois, Michigan, Wisconsin, Indiana and Missouri.

The standard recommendations of the U. S. Fuel Administration are substantially as follows:

A. That means be provided for measuring and recording fuel used each shift or day.

B. That boiler feed water be heated by exhaust steam or waste heat, and measured.

C. That a correct amount of air be supplied to the fuel, and that proper means be provided for measuring and regulating the draft.

D. That boiler heating surfaces be kept clean inside and out.

E. That the furnace and setting be kept in good repair, and free from air leakage.

F. That exposed steam surfaces wasting heat by radiation be covered with suitable insulating material.

G. That wherever possible, exhaust steam be utilized to the exclusion of direct steam from the boilers. (The plant should be designed and operated to produce no more exhaust than can be efficiently utilized in heating and process work.)

H. (a) That a competent employe or committee be detailed to supervise the work of fuel conservation in the boiler and engine plants; and (b) that a competent committee be appointed in charge of the work of fuel conservation in the buildings and shops outside of the power plants.

The Fuel Administration is preparing a series of official bulletins on engineering phases of steam and fuel economics, some of which are now in press. They will include: 1—Boiler and Furnace Testing. 2—Flue-Gas Analysis. 3—Saving Steam in Heating Systems. 4—Boiler-Room Accounting Systems. 5—Saving Steam and Fuel in Industrial Plants. 6—Burning Fine Sizes of Anthracite. 7—Boiler-Water Treatment. 8—Oil Burning. 9—Stoker Operation.

The slogan of the campaign is, "Maximum production with minimum waste." In other words, the object is to operate all industries at full capacity, but at the same time to make a pound of fuel perform its maximum service in power, light and heat.

The services of every competent power plant and fuel engineer in the country will be needed to assist in the effective execution of the government's plan of fuel conservation. This is a tremendously important service. Many engineers with special knowledge in steam and fuel economies have been looking for an opportunity to serve their country in the way of maximum effectiveness. Their opportunity has arrived. Let them send their names to the Administrative Engineer in their state, or to the Fuel Engineering Division of the U. S. Fuel Administration, with full particulars as to what manner and it what localities they can serve.

Impurities in Coal

On this topic, E. L. Cole, secretary of the Conservation Division of the Federal Fuel Administration for Pennsylvania, called attention to the work in that state and to what William Potter, fuel administrator, is doing to correct harmful practices in coal mining and shipping in that state.

As increase in impurities in coal during the winter of 1917 became evident, friendly suggestions were made to mine operators, but in vain. Rules were then formulated by the Fuel Administration, co-operating with the Pennsylvania administrator, and a system of inspection started to limit the percentage of slate, bone and under sizes allowed in anthracite shipments. The effect is shown by the fact that in January and February over 50 per cent of coal shipped contained excessive amounts of impurities, but was allowed to be shipped to avoid delay during the period of fuel famine; while in May less than half of one per cent of the anthracite production was condemned, and this was reprepared at the mines before delivery.

Various penalties have been inflicted for violation of the rules, including repayment of part of the charge made for the coal and like part of freight and cartage costs, dumping of coal so dirty as to be unusable, donation of coal to churches and hospitals and reshipment to mines for cleaning. Some mines have been closed down until apparatus and methods for suitable cleaning of the coal were installed.

It is the observation of the Fuel Administration that steam sizes of anthracite containing 40 per cent of impurities are so inefficient in generating steam that the cost of such fuel is commercially prohibitory.

Allowable Limits for Impurities

Steam sizes of anthracite containing not more than 20 per cent aggregate impurities enable firemen to maintain maximum steam under the most difficult conditions. When the amount of impurities exceeds 20 per cent, there is at once a noticeably increased amount of fuel required to maintain normal steam pressure. In addition to this, there is an increase of 10 per cent in the cost of fuel when the percentage of impurities is increased from 20 to 25 per cent, and a further increased cost in the removal of ashes.

However, expert firemen obtain fairly good results with anthracite steam sizes containing as high as 30 per cent of slate and bone, but the fuel costs show an increase of 25 to 37 per cent above the cost of the same size fuel containing only 15 per cent of impurities.

Any steam anthracite containing more than 30 per cent of slate or bone is too expensive for the manufacturer to purchase today, according to our observation. All steam coal containing more than 20 per cent of impurities is condemned when it comes under the observation of the Fuel Administration. This is so even when it is found at destination points in Pennsylvania.

Impurities in Domestic and Heating Sizes of Anthracite

The effect of increase in impurities in domestic sizes of anthracite is much more marked than in steam sizes. The domestic sizes include pea, nut, stove, egg and broken coal.

Excellent results are obtained with pea coal containing 8 to 10 per cent of slate and the same amount of bone. That is a total of 16 lb. of impurities in 100 lb. of coal.

When the amount is 11 to 12½ per cent of slate, satisfactory results are obtained, but ashes must be removed at more frequent intervals, and more attention given to the fire. At the same time, there is an increase of at

least 5 to 8 per cent in the cost of fuel. This applies equally to this size of coal in use of low-pressure and high-pressure service.

Pea coal containing 20 per cent of slate is worthless for low-pressure boilers. In high-pressure practice, fairly good service can be obtained, but ashes must be removed at more frequent intervals and more attention be given to the fire. At the same time, there is an increase of at least 5 to 8 per cent in the cost of fuel.

In high-pressure practice, fairly good service can be obtained with 25 per cent of slate, but the cost of such fuel is virtually prohibitory. The larger the size of anthracite, the lower must be the percentage of impurities to obtain maximum service. No shipments of pea coal with more than 12 per cent of slate are permissible.

Chestnut gives best results when impurities do not exceed 5 per cent of slate and an equal percentage of bone (bone contains 50 per cent of carbon). Any increase above this figure is marked by inferior service. At 15 per cent fires must be carefully attended, or it will be necessary to relight them twice within 24 hr. Chestnut coal containing 20 per cent of slate is so inferior that any price for such fuel is exorbitant. All nut coal containing 7 per cent of slate is condemned by the Fuel Administration.

Stove coal containing 5 per cent of slate and 6 per cent of bone gives maximum service. At 6 per cent of slate and 7 per cent of bone, the result is increase of 8 per cent in fuel costs. This size coal containing 8 per cent of slate and 9 per cent of bone shows the maximum possible amount of impurities that can be used by domestic consumers, discounting the high cost of such fuel. Any percentage above this renders the fuel worthless.

Egg coal should not be used when the amount of slate is more than 4 per cent, and 5 per cent of bone. This size of coal is difficult to burn unless it is virtually free from slate. Our standard permits 2 per cent of slate and the same of bone, and because of the size of this coal (it is the size of an average fist) the slate can be readily removed by the consumer. It is much better to do so than to obtain inferior results by shoveling the dirty coal into the furnace. It may be stated that the amount of slate allowed in this coal is only equal to one piece of slate in 100 lb., and two pieces of bone in the same weight.

Broken anthracite must be virtually free from slate or bone. Even in foundry practice, as well as domestic service, it is necessary to remove all slate from this coal before it can be used. It can be readily perceived that this is imperative when the inspection schedule only allows 1 per cent slate and 2 per cent of bone. This is less than the weight of a piece of bone or slate of this size of fuel. During January, many cars of broken anthracite were shipped from the mines into Philadelphia containing from 12 to 25 per cent of slate.

Mr. Cole gave further facts as to the work done, and at the end, R. J. S. Pigott, of Bridgeport, Conn., offered the following resolution, which was adopted:

Whereas, a large proportion of the shortage of fuel is due to reduction of capacity and efficiency, occasioned by the increase in non-combustible impurities in coal as furnished from the mines, due chiefly to negligence on the part of the operators; and to the consequent increase in tonnage hauled for a given total heating value. And

Whereas, William Potter, Fuel Administrator of Pennsylvania has taken effective steps to force the proper cleaning of coal by establishing inspection at the mines, standards of quality and punishment for infraction,

Be it resolved, That the American Society of Mechanical Engineers endorse and support the action of the above mentioned Fuel Administrator of Pennsylvania.

Sulphur and Clinker

W. S. Gould spoke of this feature, stating that there is a drop of 1.5 per cent in boiler capacity for each 1 per cent of sulphur, because added clinkers are found interfering with air distribution. The result may be either excess or deficiency of air, thus reducing efficiency or combustion rate or both. While before 1916 Eastern coals seldom carried over 3 per cent of sulphur, during the last winter 5 and 6 per cent has not been rare, and there has seldom been less than 2 per cent.

Besides, the sulphur causes damage to tubes, plates and grates which is hard to estimate, but is usually serious. In one case grates were totally destroyed in 4 hr. when using coal carrying 3.5 per cent sulphur, although a similar coal with 2 per cent had been used without difficulty.

B. S. Murphy, drawing conclusions from tests on 900-hp. B. & W. boilers using anthracite either alone in No. 1 buckwheat size or in Nos. 3 and 4 buckwheat mixed with bituminous, stated that poorer coals with 24.25 per cent ash tested 10,294 B.t.u. for wet coal, while better coal with 9 per cent ash tested 12,000 B.t.u. The limit of successful burning was found at 30 per cent ash on account of the greater work in cleaning hand-fired grates. Ashes accumulated during periods of peak load so that it was difficult to get past the peak without cleaning fires, and an ashpit pressure of 7 in. of water was, at times, necessary. Impurity of even 16 per cent may form a light puffy ash bed which will require cleaning every ¾hr., but the anthracite seldom forms large, hard clinkers as does bituminous.

When running at 150 per cent rating, and with No. 3 buckwheat containing a large amount of impurities, it is necessary to level fires every 3 to 4 min. This is hot, hard work, and the tendency is to "bail" in coal, the fire building up until it becomes so thick that air cannot be gotten through it. Cleaning, then, wastes a large amount of unburned combustible to the ashpit, forming another source of loss. With good fuel and firemen the loss to ashpit was 20 per cent, while with the dirty coal of January to March last, the loss ran up to 40 and even 44 per cent; all this increased the coal consumption per kw.-hr. by some 53 per cent.

W. L. Abbott mentioned tests on a chain grate stoker which showed that while coal containing 40 per cent ash would burn, it would not make steam.

H. Kreisinger, however, stated that near the mines washery refuse containing less than 50 per cent combustible can be used profitably, and on tests such fuel has developed 75 per cent of a boiler's capacity with over-all efficiency of 47.5 per cent; 8.6 per cent of the combustible going into the ashpit, the heat from 22.5 per cent being absorbed by the boiler, and 10.4 per cent going up the stack. The balance was lost by radiation

and incomplete combustion. Draft at the base of the stack was 0.92 in. water, 0.06 in. in the furnace, and 0.75 in. pressure in the ashpit. Average thickness of fuel bed, 16 in. Such practice should be carried out, however, only right at the source of the fuel, for railroad cars should be used to ship only clean coal.

Fuel Oil for Power Plants

From the statements of many speakers, it was evident that fuel oil as a substitute for coal is, at present, out of the question on account of both high price and scarcity of the fuel oil.

While better efficiency may be obtained, and labor required is less, the outlook is that prices will be higher for oil, and that the need for it as a fuel for naval ships will soon require the total available supply. No such oil is now available from eastern fields, the southern and Mexican being the only available sources, and output from the latter is not dependable.

For the future, the main supply would seem to be the shale rocks which contain many times the amount available from known well regions, but these rocks are not, as yet, worked to any extent.

E. H. Peabody gave some valuable data on fuel oil, stating that an oil-burning furnace can be run at better efficiency than one burning coal, but, also, can be run at poorer efficiency, if improperly handled than could be from a coal fire without the fire going out.

Approximately 1 lb. of oil equals 1.5 lb. coal in actual steam made, or 4.5 bbl. of oil equals a long ton of coal. When the price of coal in dollars per long ton is double the price of oil in cents per U. S. gallon, the cost of fuel for producing a certain boiler capacity will be the same for both fuels.

In general, one oil burner will be required for each 350-400 boiler horsepower, and one fireman can tend to 10 burners, or 4000 boiler hp.

Efficiency will be, on the average, 10 per cent higher with oil than with coal.

In varying the rate of combustion of oil, the amount of fuel itself and the rate at which it enters the furnace must be varied, and the amount of air entering with it must be increased or decreased to preserve the proper ratio.

Lighting of an oil fire is a simple process. The oil pump is started to give the necessary oil pressure at the burners. The draft is opened to provide sufficient air for combustion. A lighted torch is then placed directly under the burner tip, and the oil is then turned on. If the oil is at the proper temperature and the atomizer is working properly, the spray at once bursts into flame. The spray must never be started without first lighting the torch; i.e., no oil must be injected into a "dark furnace," for if it is, an explosive mixture may be formed in the furnace which will cause damage if ignited.

There is little or no difference in the action of compressed air and steam in atomizing oil as far as boiler work is concerned and if the air is compressed to over 30 lb. per sq. in. there is no special difference in the design of the burner itself.

So far as the steam boiler furnace is concerned, however, the prospective user of oil may forget the air atomizer, the one instance in which its use might be considered, being that in which the saving of fresh water (consumed by the steam atomizer) is a matter of importance. And in this case, a mechanical atomizer will probably do the work effectively, and will be preferred.

As between the claims of the steam atomizer vs. the mechanical atomizer, the issue is not as clear cut. On board ship, except in the case of harbor vessels or those making port every day, the steam atomizer has given way to the mechanical atomizer, where the saving in fresh water for the boiler makes the use of the latter type practically imperative.

There is practically nothing to choose between the two types in operating results under equivalent conditions. The steam atomizer is, however, more flexible, i.e., the individual burner has a greater range in capacity; it costs less to install, notwithstanding that it requires two lines of pipe (oil and steam), whereas the mechanical uses only one, and that for the oil. It is more readily applied to a coal-burning furnace, and conversely the furnace is more quickly converted back again to coal. It requires a lower oil pressure and not so high a temperature for viscous oils. It will also, in general, require less draft to operate. Furthermore, where special arrangements of burners are required, as in the case of the so-called "back-shot" burner (placed at the rear of the furnace), the steam atomizer is susceptible of a wide range in design which has been found useful.

Oil Pressure and Temperature

For steam (or air) atomizing burners, oil pressures of 25 to 50 lb. at the pumps are adequate, and under certain conditions even less pressures. Overhead tanks a few feet above the burners, feeding the oil by gravity, have been employed, but this is inadvisable on account of danger of fire, and pumps are usually employed. Mechanical burners require pressures of 50 to 250 lb. at the burner tip, 200 lb. being a favorite pressure for the designer. The wide range of pressure is useful in adjusting the burner capacity. A steady oil pressure is a necessity for oil burners, a vital necessity for mechanical burners. Therefore large air chambers on the oil line are needed if the usual duplex reciprocating pump is used. Rotary pumps are being introduced in the Navy, and recently the screw pump has come into vogue. These pumps give a steady pressure of oil with little or no air cushioning, and the screw pump, particularly, seems to possess great possibilities for this work.

The matter of heating the oil is rather of a mechanical nature as its importance bears on the viscosity of the oil rather than on any thermal advantage. Steam atomizers will handle more viscous oil than the mechanical type, therefore steam heaters using exhaust steam from the pumps and capable of heating the oil to 100 deg. to 125 deg. F. are usually satisfactory. The mechanical burner requires that the viscosity of the oil be reduced to 8 to 10 deg. Engler to spray properly, and this means that the oil (according to its viscosity) must be heated to 120 deg. to 280 deg. F. The latter temperature is required for heavy viscous oils that are appearing on the market to a greater and greater extent. In a mechanical-burner installation it is evident that the oil heater is a most essential part of the equipment.

Importance of Air Regulation

To a certain extent the amount of air being delivered to an oil fire is indicated by the color of the flame, a very bright, intense white (so desirable with coal) usually indicating that too much air is being used, with a resulting loss in efficiency. Judging the fire by the flame, however, is only approximate; and it is better to resort to the simple device of diminishing the air supply until a light brown haze appears at the top of the chimney. This is preferable to a clear stack, as the latter gives no indication of excess air. The light haze is not at all objectionable and in fact represents good conditions—and this is a most important point—the smoke which produces the haze does not come from one or two burners only, while all the rest are working with oil. Complete combustion in the furnace (that is, combustion in which all the carbon is burned to CO_2 and no CO is present) will give an analysis with coal in which the CO_2 content, plus the free-oxygen content, will add up considerably higher in amount than an analysis of the products of similarly complete combustion of oil. The same percentage of CO_2 in the gas sample from coal indicates a much greater excess of air over that theoretically required than when oil is being burned. However, complete combustion of oil can be secured with a much lower amount of excess air than coal fuel; and it happens, therefore, that 14 per cent CO_2 in both cases represents the same satisfactory conditions in the furnace with both fuels.

The amount of air theoretically required for the complete combustion of fuel oil of course varies with the composition of the oil, but it may be considered that about 14 lb. or 183 cu. ft. at 60 deg. F. represents the average.

Boiler Furnace for Oil Fuel

In oil burning, "furnace volume" possesses a function similar to that of "grate area," in burning coal fuel. The rate of combustion of oil per cubic foot of furnace volume may be increased or decreased according to the intensity of the draft. A large furnace is necessary, therefore, if the draft is low, and the furnace can be made smaller if the draft is increased. This effect of furnace volume on the rate of oil combustion is often ignored or misunderstood; but it is of prime importance.

A high furnace temperature promotes the combustion of oil. Owing to the less quantity of excess air, oil furnaces are usually higher in temperature than those burning coal, so that good quality firebrick with a fusing point at least 3000 deg. F. should be used. Notwithstanding the higher temperature, if the burners are set and operate properly so that no flame impinges on the wall and no hard carbon is deposited, the wear and tear should not be great.

W. N. Best gave somewhat different figures for the value of oil, stating that 147 gal. of oil weighing 7.5 lb. per gal. will equal a long ton of coal, heat values being 19,000 and 14,000 respectively per pound. At this figure, oil at 5 cents a gallon would be equal in cost to coal costing $7.35 a ton delivered in the bin.

Mr. Best advocated installation of oil burning equipment as an emergency provision against shut down in case of failure of coal supply, and to assist in carrying peak load, using a combination coal and oil fire. He would set the burner in the side wall, midway between bridge wall and front end, or in the front end in position not to interfere with the fireman or mechanical stoker. Provision is made by a slide gate for air needed to burn the oil, and the gate is opened just enough to give the air required for perfect combustion of the oil required in addition to the coal. Any proportion of coal and oil may be used, or the grate covered with ashes and oil used exclusively.

(To be Continued.)

There's a Reason

Don't kick. There may be a reason. We were left without coal last winter and were nearly frozen. But we know now that the coal was needed to bunker the cargo boats that were carrying our supplies to France. If they hadn't carried it, the German drive that began in March might soon have found the allies without food and ammunition both.

When we weren't allowed to give our boys any brass-band send-offs, the censors' reasons seemed foolish and absurd. But we know now that while we thought our boys were only sailing in regiments, they were going in divisions. And where Germany believed there weren't a hundred thousand of them in France at most, she is just beginning to learn that there are more than half a million.

Some of our no-wheat bread is pretty bad, and maybe you feel like kicking about that. But our bread has never been half as bad as it is in France and England. You know now how much our wheat is needed. And a bushel will furnish a gunner or an airman with his bread ration for a month. Supposing your bushel of wheat should some day send out an airman to drop a bomb on the whole German general staff, how will you feel about it then?

Speeding Up

At Camden, N. J., the 5500-ton steel ship Tuckahoe was launched by the New York Shipbuilding Corporation in 27 days from the date of laying the first keel plate. This cuts the previous low record made by the Skinner & Eddy Corporation, of Seattle, Wash., of 55 days for an 8800-ton vessel, in half, and the ship will be ready to sail 42 days from the starting of the keel. Not long since, 90 days was considered a remarkable record, but the pace set has sent that mark tumbling. The work on the Tuckahoe is an excellent example of what systematic planning and follow-up charts can do. The management decided on April 8 that they were in position to go after a record and formulated a schedule which was estimated to put the ship in the water in 27 days, 4 hr. and 50 min. from the time work was started. The actual time taken was 27 days, 3 hr. and 10 min.

In one plant the fireman has a brace of hens domiciled in the yard for convenience in attending them. Lately they have taken to laying in a pile of stored coal; and the Chief says they must have read and obeyed Garfield's warning, "Now is the time to lay in your coal."

Breeching Built of Old Ice Cans

SHOWN in the accompanying illustrations are two views of a breeching made last winter by the engineers and tank-room help at our plant. The entire flue was constructed of the stock of old ice tanks, the sheets used being riveted to 2½-in. angle irons and reinforced on the sides with 1¼ by 3/16-in. tees.

Some of the readers of Power Plant Engineering may take exception to the size of this breeching as compared to that of the stack. In regard to this I wish to state that the chimney was originally designed and built for use in connection with boilers larger than those we have at present; but as conditions have up to the present been unfavorable for obtaining new steam generating units, we decided to connect the old boilers to the new stack, as the old one was found to be of insufficient capacity to care for the load, even with forced draft.

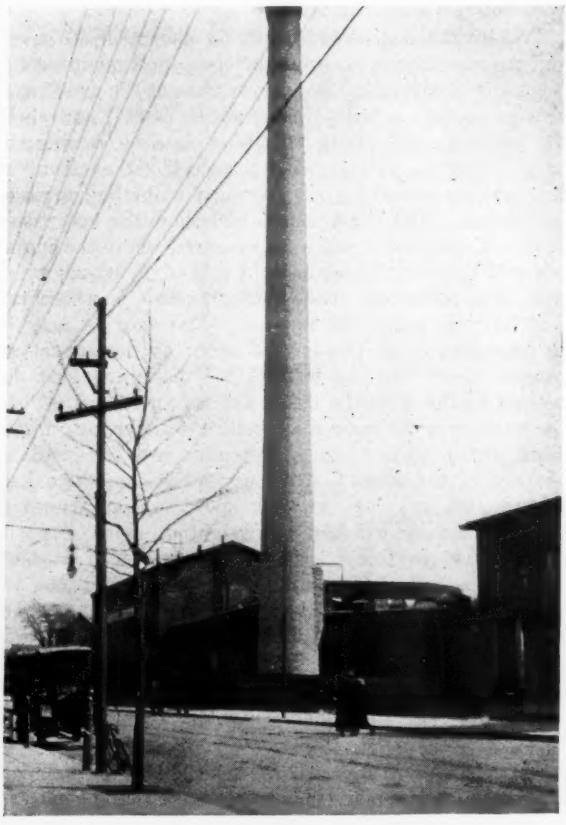


FIG. 2. BREECHING AND STACK

Its overall length is 65 ft., and its sectional dimensions are 42 by 42 in. A 90-in. elbow having a damper fitted in the vertical run connects this breeching to a section above the boilers which is 36 in. in diameter; a 45-deg. bend was required on the roof.

No riggers of any kind were required, as each section was built up and then carried to the roof, where the assembling was done. In building up the sections, we used the rusty sides of the can on the inside of the breeching and in that way obtained a smooth galvanized surface on the outside. This we then painted, but for some reason or other the paint we used persists in coming off and I wish that if any of the readers know of a preparation or paint which will adhere to hot galvanized iron they would let me hear about it.

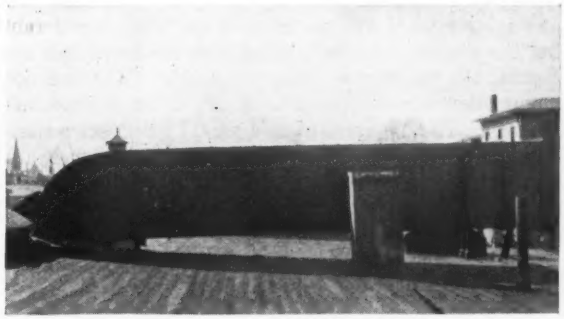


FIG. 1. SECTION OF BREECHING BUILT OF OLD ICE CANS

M. M.

Curing Leaky Pistons

IT IS always interesting to know how a difficulty is finally overcome. Last November one of the readers of Power Plant Engineering sent a request, which was published, for help in curing oil leakage past the pistons of a 2-cylinder vertical engine of 20-hp. rating which was so serious as to drown out the spark plugs after a couple of hours run.

Numerous suggestions were made and published in Power Plant Engineering including a diaphram between crank case and cylinders, grooving the piston and draining oil to the interior by ⅛-in. holes, re-boring cylinders and fitting new pistons, using two or three-piece piston rings, using heavier oil, re-grinding valves.

One maker of oils who read the request took the trouble to send an expert on lubrication to help out our subscriber if possible and the history of his success is of interest.

The motor had jump spark ignition, positive oil feed, throttling governor, double expanding pistons and hand adjusted timing. Lubrication was splash for pistons and rods with cups for external bearings; speed,

350 r.p.m.; fuel, natural gas; lean and carrying considerable moisture.

The trouble was from oil working past pistons, forming hard carbon which caused pre-ignition and fouled the spark points.

Texaco Alcaid oil was placed in the crank case on Feb. 11, the engine started and run for 2 hr. without load; then full load was thrown on. After adjusting cooling water and air supply, the engine ran 5 hr. temperature of the crank case being taken at half-hour intervals. With the case closed, the temperature increased 40 deg. in 4 hr. Then two 2-in. pipes were put in for crank case ventilation, the oil was drawn from the case and a new supply put in. After 3 hr., the temperature was only 2 deg. higher than at the start. It was stated that this was the first time the engine had run since bought without fouling or trouble.

Next morning oil was drawn from the crank case, the engine started and watched to see what vapor came past the pistons. As the pistons were cold and had contracted, the vapor was quite noticeable. The engineer thought the oil would need to be drawn off at least once a month. The expert said this would help, but advised that instead of putting on the circulating water full at starting as had been done, the engine be started with little circulating water; then bring the water up to full feed after it began to get warm.

Oil was then put back in the crank case and ran all day without trouble.

As a result, Mr. Nigh, our subscriber, wrote to the Texas Co. as follows on March 6: "We were unable to operate a 20-hp., 2-cylinder gas engine for more than an hour without trouble, due to the oil reaching the ignition. Your engineer, after investigation, laid this to lubrication and we have now operated this machine daily for 30 days without any trouble and can assure you Alcaid oil is doing all he claimed for it."

We give this as the final chapter in the story to show the aid that Power Plant Engineering readers can get through its pages and its advertisers.

Balancing Engine

THE QUESTION of balancing an engine is one that cannot be answered with any degree of accuracy without knowing more of the conditions than are given in the inquiry on page 425 of the May 15 issue of Power Plant Engineering. There are three things which affect the balance of an engine, any one of which may be either the direct or the contributing cause of the trouble and they are unequal steam distribution, a lack of or misplaced (possibly erroneously would be better) counterbalance, either in the balance wheel or the crank discs and a governor which has a tendency to "hunt," due to possible mal-adjustment.

If the valve setting has become so faulty as to admit more steam to one end of the cylinder than the other, it can readily be seen that this impulse at each revolution will cause a vibration. The first thing to do is to be sure that the valve setting is as good as the conditions will permit; this remedied, then look for the next possible cause.

The question of the proper weight of counterbalance to place in the wheel of an engine or in the crank disc is more or less of an experiment with most builders and especially in the first high-speed engines manufactured, but of late years they have learned by experience. The writer has seen engines of the high-speed type entirely devoid of any counterbalance in the crank which ran in a very satisfactory manner, while others which were designed according to the latest ideas of calculating the proper weight of counterbalance had so much vibration as to be annoying in the extreme. In another instance, a large three-cylinder triple compound engine of nearly 3000 i.hp. running at 225 r.p.m. threw one of the "fan tails" on the i.p. crank disc, which fortunately detached itself so as to clear the engine without any further damage. The loss of the counterbalance weighing about 800 lb. did not affect the running of the engine in the least; in fact, it was not shut down until the closing hour and the weight was never put on again.

Fan tails of crank discs are usually restricted in size, owing to lack of space, unless the disc is of sufficient diameter to allow the extreme radius of the counterweight to exceed greatly that of the crankpin. This has been used to good advantage by a few high-speed engine builders, even by builders of steam tractors. In such cases the flywheel is given a "dead balance" the same as is done on auto engines.

Where the engine is already in operation, however, and the vibration is excessive, after seeing that the steam is equally distributed, clean the surface of the wheel with benzine so that it will "take a chalk mark" and chalk the wheel several places on the surface by resting the hand about on a level with the shaft either front or rear and on something not in touch with the engine or foundation. The chalk marks will show the heavy side of the wheel and the shorter they are the more the engine is out of balance. Find the light side of the wheel, which will be opposite the chalk marks, as this is where you will have to place the weights. The weights may be in one place or in two spaced about 45 deg. apart arranged about like the letter "Y," assuming that the bottom of the Y is the heavy side of the wheel. Place the weights in the same plane with the spokes and fasten them with a ½ or ¾-in. stud tapped into the inside of the rim of the wheel. All you need is enough to hold the weights in place at slow speed; when running, centrifugal force will hold the weights in place. As trial weights use anything, such as large cast-iron washers, old handhole plates or similar junk that is available, but take care that it does not stack up too much; rather have it large in area and thin.

Run the engine after each change of weights (preferably with as near full load as possible) and chalk the wheel and note the general behavior of the engine as to vibration.

By using a little care the engine can be balanced perfectly and be made to operate on a foundation that rests on very poor soil; but be careful not to over do the job. Finish the adjusting with small weights such as cut washers, etc. When you have attained a "happy medium," remove the weights and the stud that holds them on and weigh each set of weights separately. Then make a neat and symmetrical weight out of scrap lead, babbit, etc., or if you have a foundry in connection, cast-iron weights of neat design can be made and metal drilled out if necessary to bring the new weights to the

proper size. If the lead or scrap babbit is available, weigh the amount to correspond with the trial weights, adding a little for dross. An old oil boat off a hanger makes a fine mold in which to pour such a weight, or take a stiff hat and press into it sand enough to make a weight the proper size. After it cools, compare the weights with the trial weights and chip off if necessary. A little "filler" and paint will make a neat job.

The third possible cause of the engine being out of balance, namely, the governor hunting may have been caused by changing the weights of the governor at some time or other to give the engine a new speed as required. The engine may have been placed in proper balance by the builder at a certain speed; but if the balance of the governor has been changed or a different spring substituted, this will naturally throw the engine out of balance.

If the soil on which the engine foundation stands is soft or spongy it may be strengthened by digging down around it and partly in under it (say a foot or so) and filling in with concrete, using reinforcing bars to strengthen. At any rate, give the matter the very best that is in you, for, as was said at the beginning, no matter what advice may be given here, the man on the job must use good horse sense to get the best results.

GEORGE H. WALLACE.

Lubricating Low-Pressure Cylinders

THE USUAL PRACTICE is to use the same oil in both cylinders of a compound engine and usually fair results are obtained. To secure the best results an oil suited to the lower pressure and more moisture present in the low-pressure cylinder ought to be used in the low-pressure cylinder.

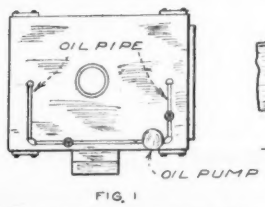


FIG. 1. USUAL OIL PIPING TO LOW-PRESSURE CYLINDER

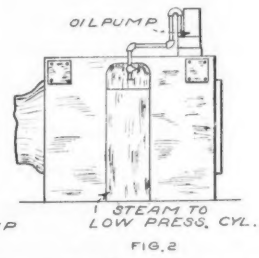


FIG. 2. OIL PIPED TO STEAM INLET

Figure 1 shows the general method of piping the cylinder lubricator on the low-pressure cylinder of Corliss compound engines. It will be noted that the oil is discharged into the center of the top of the steam ports and we expect the oil to find its way to the bearing surfaces of the steam valve heads and stems in the bonnets unless the through valve stem is used.

Having trouble in properly lubricating the valves in the five low-pressure cylinders in our plant when piped as in Fig. 1, we drilled and tapped the hole for the lubricator in the steam belt on the side of the low-pressure cylinder as shown in Fig. 2.

The steam on its way to the steam chest surrounds a portion of the low-pressure cylinder in the steam belt shown. We stopped one of the feeds on the double connection pump lubricator, giving the other feed twice its former amount so the cylinder would get the same quantity of oil as before.

The engineers said that the oil would not be carried along as expected, but drop to the bottom of the steam belt. To find out the state of affairs, we connected a trap into the bottom of the steam belt and noted the discharge. While some oil came out with the condensate, all were surprised at the small amount while all admitted the engine ran better.

By placing the hands on the valve gear it was felt to move more smoothly and when using the bar the easier working was noticeable. Examination of the valves after a month's run showed more oil on the valve surfaces and cylinder wall than under the old conditions, the same brand and quantity of oil being used.

We have always used graphite in the cylinders, putting it in this way: A small funnel is put into the indicator cocks and a teaspoonful of graphite put into the funnel. While the engine is drifting after closing the throttle and breaking the vacuum, the indicator cocks are opened when the graphite is drawn into the cylinders.

RECEIVER.

Feeding Shavings

TO GIVE D. J. B. information in regard to feeding shavings to boilers, I wish to state that we feed all our shavings to the boilers. We collect the shavings from one end of the shop through a suction blower fan from which they enter a cyclone located on the roof of the factory; from this cyclone the shavings fall by gravity into another blower, which also collects shavings from the other end of the shop and from here the blower delivers them into a cyclone on the boiler room roof, from where they are allowed to fall by gravity into the boiler furnace or a storage vault, as the fireman may see fit. A damper in the pipe line allows him to shut off the flow from the boiler and then it empties into this vault. He must have a cyclone, otherwise the air from the blower will give much trouble, such as leaking tubes, cracking boiler walls and grate trouble. In other words, the air must escape through the cyclone and not enter the boilers.

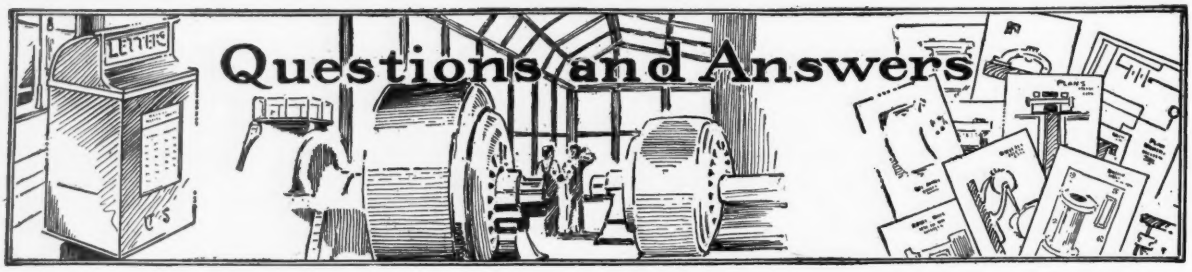
He also complains about the high price of coal. Has he ever stopped to figure how much wood he burns in proportion to coal? I have, and have found that coal is cheaper than wood; for instance, I get $6.50 for a load of wood; I burn four loads of wood to one ton of coal, and as the price of coal delivered at the boiler room is $5.75 a ton, four loads of wood at $26 provide a saving of $20.25. So I am selling all the wood I can sell. The hauling of wood does not cost a cent, because the teamster while waiting for a load for his own wagon takes his horse, hitches onto the wood wagon and delivers the load. By the time he returns his load is ready, and if not he continues to haul wood until it is.

If D. J. B. is looking for more information in regard to cost of the installation, etc., I will gladly give it to him.

WM. C. FUNK.

HARTLEY WITHERS, the editor of the Economist, of London, says: "Money spent in war time on things not needed is money given to the enemy."

REMEMBER! the men in our Army and Navy do not expect luxuries. Should we at home expect them? Buy necessities and War Savings Stamps.



Reclamation of Coke

I WOULD LIKE to ask the readers of Power Plant Engineering if any of them know of a practical method for the reclamation of coke from ashes, suitable in connection with a plant consuming about 200 tons of coal a day.

If you do, let us hear from you. W. H. M.

Chain Drive for Ammonia Compressors

DO YOU think it practicable to drive a 10 by 18-in. 25-ton ammonia compressor running at a speed of 75 r.p.m. by means of a silent chain drive? I desire to obtain some data on this subject and would like to hear from other readers of Power Plant Engineering, who have already used such form of drive, as to results they have secured.

E. S. R.

Proper Machine Locations

WILL SOMEONE be kind enough to point out to me the advantages to be gained by having the ceiling or ironwork in a factory building 14, 16 or 18 ft. above the floor? Just because the ceiling is above the floor, must all shafting, line and countershafts, be fastened to the ceiling or ironwork?

Let me put this question in another way. Several machines were to be moved from an old building, where the ceiling was low, to a new factory building having 16-ft. ceilings. Five of the machines were for special work and were designed with six-speed cone drive. Frequently the speed of these machines was changed during the day while in operation. The distance between the countershaft and the lathe was 4 ft. 3 in.; the shifting of the belt from one speed to another was easily and quickly done. Operation and upkeep gave very little trouble and the output of the machines was in every way satisfactory. Everything was so convenient and handy and the operators were so accustomed to existing conditions that they asked that the machines be set up in the new building as near as possible in the same relative position as that which they occupied in the old building. In order to comply with their request it was necessary to fasten a plank to the side wall of the new building and to this plank the countershafts were fastened. The job was done in a way quite satisfactory to both the foreman in charge of the department and the operators of the machines, but here's where the trouble started. The moving and resetting up of these machines was done in the absence of the boss millwright and without his consent. Upon his return, he ordered that these countershafts be changed from their present location to the ceiling, or, rather, the structural steel work 16 ft. above the floor. His excuse was that placing the countershafts on the wall was not in keeping with good millwright practice. In other words, good millwright practice was of much more importance than ease and convenience for the operator in the performance of his work. Now, the millwright does not operate the machines, neither is he responsible for the output of the machine. The department foreman is responsible for the output of the machinery in his charge, but he does not operate the machines. The operator of the machine is the person who produces the goods; it is he and the little things that are a help to him in getting out his work that should be considered first.

A certain foreman who was always complaining about short belts some time ago purchased a power-driven rip saw having the countershaft attached to the frame, the distance between the saw arbor and the countershaft being 3 ft. 6 in. His reason for purchasing this close coupled machine was that "the machine was built that way." Now, if a woodworking machine that requires from 7 to 10 hp. to drive it can be operated with a close coupled shaft and a short belt, I know of no good reason why a wood or metal working machine with the countershaft 4 ft. 3 in. above them will not work equally well.

What is your opinion? M. E. D.

Horsepower Requirements of Elevators

HOW CAN one determine the number of horsepower required to operate a hydraulic elevator? J. W. C.

A. Power requirements depend upon the speed, capacity, etc. Power is usually required for motion in one direction only for hydraulic elevators. Let L= weight of live load, lb.; U=unbalanced weight of car, lb.; S=speed of car, in feet per minute, and e= efficiency of complete elevator, per cent. Then horsepower is equal to

$$\frac{100\ (L+U)\ S}{33{,}000\ e}$$

In determining the horsepower required to operate hydraulic elevators, allow for power on upward trip only, and for approximate results compute 2/3 of the amount required to operate all elevators at one time under full load.

The steam required per car mile, using a flywheel type pump, ranges from 150 to 250 lb., based on 25 lb. of steam per indicated horsepower of the pumps.

The Inductor Alternator

WILL YOU kindly give me some information regarding the construction and operation of the Warren inductor alternator? Could two such machines rated at 60-kw., 1100-v., 60-cycle, two-phase each, be operated in parallel with any degree of satisfaction?

J. L. M.

A. In an inductor alternating-current generator, the armature generally consists of a stationary laminated ring, the winding being embedded in slots in its inner surface. This ring is fixed inside a cylindrical frame or yoke, which, with the revolving element that rotates inside the ring constitutes the magnetic circuit.

The armature is built up of annealed sheet steel, the sheets being punched in segments which dovetail into projections in the yoke casting. Ventilating ducts are provided at suitable intervals in the core. The armature winding is composed of machine-wound coils, held in place by wedges. It is connected by insulated leads to the terminal block of the machine, which is mounted on one side of the yoke.

The revolving element carries no winding whatever and the machine has no sliding contacts. The spider or hub of the keeper is cast steel, the pole pieces being built up of laminated steel and cast with it into one piece.

The field winding consists of one large stationary coil, encircling the keeper and supported by the outer frame or yoke. This coil is separately excited with direct current. Being thus all magnetized by one and the same coil, the pole pieces are all of the same polarity, and as the keeper is rotated the magnetic lines are inserted and withdrawn from the armature coils each time a pole passes. These machines can be wound to generate either two or three-phase current.

Alternators of this type may be operated in parallel, but from the experience of the writer the results have never been very satisfactory.

Carbon in Air Compressor

OBSERVING M. E. W. in regard to carbon deposits in an air compressor, I will describe a few of my own experiences along that line in hopes that they may be of some benefit to him.

For the past 2 yr. I have been operating an Allis-Chalmers single-cylinder, four-cycle Diesel type engine of 150 hp. This engine was used as the prime mover in an ice making plant. I have lost a good many nights' sleep and have gotten several gray hairs trying to keep the carbon out of the air compressor and never did succeed in entirely doing so, although I helped matters a great deal.

Our air compressor was driven by a crank off the main shaft of the engine and as I take it, his is the same type of engine. We used an oil filtering system for the engine oil, using the same over and over again. This oil would take up small particles of carbon from the burnt gases in the cylinder that would escape around the piston on the working stroke. As this was heavier than the oil and very fine, the filter would not remove it. This did not seem to hurt the lubricating qualities of the oil, but it would carry back from the crank into the air compressor cylinder, working back into the valves. There the heat would cause the carbon to bake on the valves, making it necessary to take them out every few days and clean them, and also burnt the spring and valves out completely in time, causing us to renew them very often. On one occasion, the carbon collected in the high pressure air line, causing it to blow out and causing a shutdown for several days while we sent to the factory for a new copper pipe.

Finally, we put a bottle between the air compressor crank and cylinder, leaving just enough room for the connecting rod to work in. We took the crank oiler off from the gravity oiling system and put on an oil cup, using nothing but clean oil in it, so that if any should carry back it would not contain any carbon. We used very little oil on the air compressor proper, and that of a high grade air compressor oil that was guaranteed not to carbonize. We make it a practice to change the oil on the gravity oiling system every 30 days, cleaning it out and filling with new oil. The oil drawn off can be put in a tank or barrel and left to settle. The carbon will all go to the bottom in time and the oil can be drawn off and used again. The best thing would be a gravity system with a settling tank large enough to allow the oil plenty of time to settle before going to the filter.

By making these changes I have run as much as 30 days without a shutdown where before a week was my limit. A good air compressor oil will not form carbon to any great extent and if one can keep the dirty oil from carrying back into the air cylinder, I am positive it will help a great deal. Also see that the water jacket on the compressor is kept clean and free from scale, as the cooler it runs the less trouble you will have. Also blow out the intercooler between the two stages at regular intervals.

R. L. M.

RELATIVE to the communication of M. E. W., appearing in the June 1 issue, I offer the following:

I am of the opinion that his trouble is due to too much oil and possibly leaky discharge valves, and would inquire whether he is using sufficient cooling water, or, rather, is the space between the cylinder and outer wall free from incrustation? Is the air free from dust? Is it taken from a high, clean point?

I have been using a high priced oil for several years and have had no trouble.

Occasionally I feed a small quantity of liquid soap through the lubricator, also a little fine flake graphite via the air intake; but I am always sure it is fine flake and take good care to keep it free from impurities. Unless you wish to take a chance on "going west," together with your pipe lines and receiver, you will be wise to keep all coal oil out of your compressor. I have never tried it, although I have heard of its being used, but enough explosions from oil deposits are reported to make me careful what I mix with the air.

The temperature to which the air is raised by compression is far above the flash point of many oils besides coal oil or kerosene, so I advise "safety first."

HARRY H. YATES.

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CONTENTS

Modern Plant of Paris Medicine Co. Illustrated....519
Hints on Coal Storage Pile....523
Adapting Furnaces to Available Coals. By Osborn Monnett. Illustrated....524
What Did You? By Douglas Malloch....526
Oil Engines—II. Illustrated....527
The Care of Turbine Equipment. By W. Litzler....528
Conserve Tin....529
Blocking New Wars. By Herbert S. Houston....530
Electric Storage Batteries—III. Illustrated....533
Notes on Alternator Windings. By Gordon Fox....535
The Blind Taping Coils. Illustrated....536
Power Plants and the Fuel Administration Situation. By A. P. Connor. Illustrated....537
The Fuel Outlook....542
Letters Direct from the Plant: Breeching Built of Old Ice Cans. Curing Leaky Pistons. Balancing Engine. Lubricating Low-Pressure Cylinders. Feeding Shavings. Illustrated....547
Questions and Answers: Reclamation of Coke. Chain Drive for Ammonia Compressors. Proper Machine Locations. Horsepower Requirements of Elevators. The Inductor Alternator. Carbon in Air Compressor. Acetylene Welding Problem....550
Editorial: The Coal Outlook....552
Chicago Technical Societies' Joint War Committee....553
Red Cross Autos in France....553
Mammoth Turbines for Commonwealth Edison Co. Illustrated....554
Small Testing Instrument. Illustrated....555
News Notes....555
Books and Catalogs....556
Trade Notes....557

The Coal Outlook

Estimates by the Fuel Administration indicate that 634,600,000 tons of bituminous coal will be needed for our war demands, our industries and our homes, beginning April 1, 1918. This is 79,900,000 net tons increase over the production of the preceding year, and must be met by increased production or by conservation and limitation in the use of coal.

To produce the amount required would require the mining of 12,000,000 tons average a week, which is more than the maximum production for any week to date. There is always a tendency to delay ordering coal until late in the summer, but this must be overcome this year. Anthracite orders have been largely placed for next winter's needs, but bituminous consumers are behind, especially in the Mississippi Valley and west. Mines in the central west are not getting out full capacity because of lack of orders. Anthracite will be less available for that section than formerly, and unless householders who cannot get anthracite order bituminous coal early they may find themselves fuelless when cold weather arrives.

We have urged repeatedly that every consumer, large or small, order his coal, and take delivery at the earliest possible moment. It is not only good patriotism in co-operating with the government, but is necessary as protection against a coal famine next winter. If anyone has not done his duty in this matter, the oversight should be remedied at once.

As to the likelihood of getting coal, only two-thirds of last winter's supply can be delivered to anthracite users on the first delivery, and it is unlikely that more will be available. The balance must be supplied by mixing bituminous or by preparing to burn bituminous alone after the anthracite is gone. It is the part of wisdom to order and store enough bituminous to take the place of the lacking one-third anthracite. There will be a ready market for it next winter if it is not used.

By the coking method, central west coals can be used in almost any house-heating apparatus, pushing all partly burned fuel to one side, if a round fire pot, or to the rear of a rectangular grate, and piling the fresh fuel on the bared side of the grate, filling in as large an amount as possible.

Even though this involves some extra trouble and some smoke, it is likely to be a choice, for a considerable part of the winter, between this method or no fire.

The Fuel Administration is using every effort to insure the shipment of clean coal from the mines, and it is probable that last winter's experience of alleged coal which contained 40 to 50 per cent of slate and dirt will not be repeated this year. The standard set as of June 1, 1918, is that no bituminous coal will be permitted to be sold or shipped which contains impurities to such an extent as would not have been considered merchantable prior to Jan. 1, 1916.

In Pennsylvania, recleaning of coal, fines, reimbursement of dealers and closing down of mines have been enforced by the Fuel Administration to force operators to live up to regulations. This is being done to protect the consumer and to relieve the railroads of the burden of hauling rock and dirt which has no heat value. Other districts will be similarly inspected and

drastic means used, if necessary, to make certain that only reasonably clean coal is shipped.

As an offset, special allowance in price will be granted to mine operators who by extra careful washing or cleaning produce a coal with substantially increased heat value per pound as shipped, and it will pay consumers to get such coal where possible.

Plans are under way for assisting power plants, by government inspection and advice, to get the best possible economy in use of fuel. And, on the other hand, to regulate the supply of fuel to such plants as do not co-operate by complying with suggestions for bettering the operation of the plants. The economy will apply not only to the method of burning coal and generating steam, but to the efficient use of steam and electric current after they are generated. It is as reprehensible to burn coal efficiently, and then waste electric power, as to burn coal wastefully.

With the greatest precautions, a scarcity of coal next winter seems unavoidable. Fuel oil is also scarce, and at present prices is about twice as costly as coal for steam making. So that the only reasonable thing to do from selfish as well as patriotic motives is to make certain that every possible foot-pound of work is drained out of every pound of coal burned, and to secure as large a part of next winter's supply as possible, as soon as possible.

Chicago Technical Joint War Committee

REPRESENTING an effort to co-operate effectively and vigorously for war work, an important joint war committee has been formed by representatives of technical societies centered in Chicago. The movement was started by the Military Committee of the Western Society of Engineers, and, at the invitation of that committee, several meetings have been held at the Chicago Engineers' Club. As the result, the "War Committee, Technical Societies of Chicago," to quote the official name, was organized June 4, 1918.

The purpose of this organization is "to enable the technical societies of the Chicago zone to call into play the efforts of the members of the various societies herein represented as occasion may arise, and to co-ordinate their activities in the most effectual manner to help win the war." It is not proposed to attempt any novel "stunts," but rather to place at the disposal of the United States Government, and other authorized agencies, the combined strength and resources of the Chicago technical societies for war work, as need may arise.

The following member societies are co-operating in the new War Committee: Western Society of Engineers; Structural Engineers' Association of Illinois; Society of Industrial Engineers; Illinois Society of Engineers; Illinois Society of Architects; The American Railway Engineering Association; The Swedish Engineers' Society of Chicago; Illinois Chapter, American Institute of Architects; Chicago Section, American Society of Mechanical Engineers; Chicago Section, American Institute of Electrical Engineers; Chicago Section, American Chemical Society; Chicago Section, American Institute of Mining Engineers; Mid-West Section, Society of Automotive Engineers; Illinois Association of American Society of Civil Engineers; Chicago Section, American Society of Heating and Ventilating Engineers; Chicago Section, American Society of Refrigerating Engineers; Chicago Section, Steel Treating Research Society; Chicago Section, Illuminating Engineering Society; Chicago Chapter, American Association of Engineers.

Officers of the War Committee have been elected as follows: Chairman, F. K. Copeland; vice-chairman, W. L. Abbott; secretary, Edgar S. Nethercut; treasurer, William A. Fox.

The executive committee consists of F. K. Copeland, W. L. Abbott, William Hoskins, C. A. Keller, Charles E. Lord, C. F. Loweth, Isham Randolph and Richard E. Schmidt. The address of the secretary of the War Committee is 1735 Monadnock Block, Chicago.

Red Cross Autos in France

MOTOR trucks and cars can accomplish wholesale transportation, as is being demonstrated daily in France by the American Red Cross fleet of 634 vehicles, which not only handle an average of 2500 tons of freight monthly at 14 ports and move nearly 1000 tons a week from the Paris stations and the Seine landings, but transport supplies, workers, refugees and wounded in all sections of France, including those parts under fire. If a hospital suddenly wires in that it needs emergency supplies, if a car or truck will get them there quicker than a train, the load goes with a Red Cross driver. If a German drive threatens a village, Red Cross trucks are there to move the civilians and their belongings to a point of safety or hasten them to refugee trains waiting at distant stations. The ambulances may assist with wounded soldiers on their way back to base hospitals or may answer a call from a bombing raid to help uncover and remove the wounded. Trucks, ambulances and cars all serve at times as passenger vehicles. In two months they answered 2528 calls to move people in Paris alone—many of them being refugees to be taken from one railroad depot to another.

Speed in handling goods at the ports is an essential, and the Red Cross drivers are rather proud of moving 300 tons from one landing in a single day. A single cargo of 38,000 cases, weighing 950 tons, was handled with similar speed by the gasoline transportation corps.

FOR REGIONS where peat beds are available and coal is scarce, it may well be, in view of the coal shortage, that a peat plant will be a satisfactory solution of the difficulty. While blocks cut by hand and sun dried will burn, they are bulky, easily crushed and burn rapidly, with considerable waste. Better results are obtained by using a steam shovel for digging, a grinding mill for condensing the peat into a dense mass and a shaping press for forming blocks. Such an installation is inexpensive and easily operated, can readily be used by an association of citizens, and gives a fuel whose value per ton is equal to 1.3 tons of wood, 0.7 ton of bituminous coal or 0.5 ton of anthracite. Description of the methods of preparing peat are given in Bulletin 16, of the Bureau of Mines, Washington, D. C., which may be had free on request.

Mammoth Turbines for Commonwealth Edison Co.

FOR service in its Northwest Station, the Commonwealth Edison Co. of Chicago has ordered two 35,000-kw. tandem compound, turbo generators from the Westinghouse Electric and Manufacturing Co. One of these machines has been in regular operation since early in October of last year, while the second one is now being erected. In addition a third unit of the same

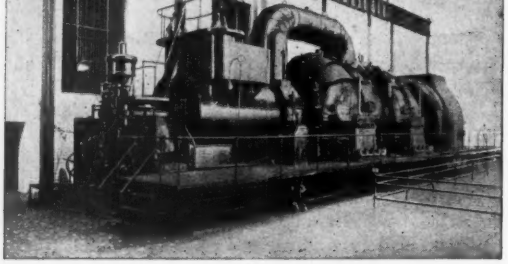


FIG. 1. TURBINE CONTROL MECHANISM

capacity is under construction for installation in the Fisk St. Station, Chicago.

Each of the two units for the Northwest station are identical and comprise a high-pressure element, a low-pressure element, and a 35,000-kv.a. alternating current generator. The two turbine elements are connected by a solid flange coupling and the generator is in turn connected through a flexible coupling so that all three rotors turn as one unit. There are five main bearings, three on the turbine and two on the generator, with an additional small bearing on the outboard end of the direct-connected exciter.

Low blade speeds and safe stresses are employed, the maximum mean blade speed being 510 ft. per sec. The bearing speeds and pressure are quite low and all bearings are served by the Westinghouse system of oil circulation and cooling. Steam passages throughout are liberal, being designed for a velocity of not to exceed 100 ft. per sec. at any point, and the passages through low pressure blades and exhausts to the condensers are ample to permit full expansion of the steam to 29 in. of vacuum. The shaft packing consists of a water gland with a steam labyrinth added, by means of which full vacuum may be established before placing the turbine in operation. After sufficient speed is attained, the water gland is put in operation and the steam labyrinth shut off.

The high-pressure element, which contains the governor and valve mechanism, is of the standard single flow pure reaction construction. The steam expands from the throttle pressure down to a pressure which varies with the load, being approximately 40 lb. absolute at rated full load. It then passes through an exhaust at the top of the cylinder into an overhead passage leading to the low-pressure element. The high-pressure rotor has only one bearing, the end of the spindle next to the low-pressure element being carried on the low-pressure bearing. High and low-pressure shafts are rigidly connected by means of a solid flange coupling. This end of the high-pressure cylinder is carried as a support on the low-pressure cylinder close to the bearing. A small dummy bearing is provided for carrying the free end of the spindle while dismantling or making adjustments, and means are provided for adjusting the position of the high-pressure cylinder to secure perfect alinement with the low-pressure cylinder.

The high-pressure spindle consists of a hollow steel drum carrying the necessary blading and two small dummies for balancing end thrust. The two separate shaft ends are rigidly attached to it by means of long press fits and held in place by means of bolts or shrink links. At the governor end is a Kingsbury thrust bearing just outside of the main bearing for carrying a small portion of the thrust and maintaining proper longitudinal alinement of the rotor and stator. The cylinder, or stator, is made of cast steel to withstand best the high temperature and pressure of the entering steam. Most of the blading is carried on blade rings rigidly attached to the

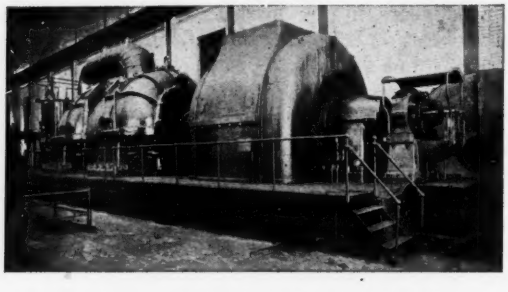


FIG. 2. ASSEMBLED UNIT FROM GENERATOR END

main cylinder, a form of construction enabling the use of plain and sound castings free from distortional stresses.

The low-pressure element is a combination of a single and a double flow construction, also employing all-reaction blading. Steam from the high-pressure element

enters at the top near the center through the overhead passage referred to above, passes through a single-flow stage and is then divided, one-half continuing through an adjacent low-pressure stage, while the other half passes back around the single-flow stage through passages between the inner and outer cylinders to the double low-pressure stage on the opposite end of the spindle. Each low-pressure stage has its separate exhaust passage to the condenser. Between the intermediate stage and the second low-pressure stage is a labyrinth packing to prevent the flow of steam from the inlet direct to the low-pressure stage.

The low-pressure spindle is built up of a central hollow drum carrying the intermediate stage blading and labyrinth packing and is rigidly attached to the two shaft ends. Upon each of these shaft ends are mounted two disks carrying the low-pressure blading. The low-pressure cylinder is entirely of cast iron and made up of a center section and two end sections, each split horizontally, and keyed and bolted together. The intermediate stage blading is carried on an inner cylinder separated from the outer cylinder sufficiently to provide space for the passage of steam to one of the low-pressure stages. The shortest blade in the low-pressure element is 6 in. long, while the longest is 18 in.

Steam admission is controlled by means of standard Westinghouse control mechanism, consisting of a powerful but sensitive governor controlling the main or primary steam admission valve and two overload valves through an oil relay. The designed capacity on the primary valve is 25,000 kw., this being the point of maximum efficiency. Designed capacity on the secondary is 30,000 kw., and on the tertiary 35,000 kw. The actual capacities of the unit now in operation are between five and ten per cent greater.

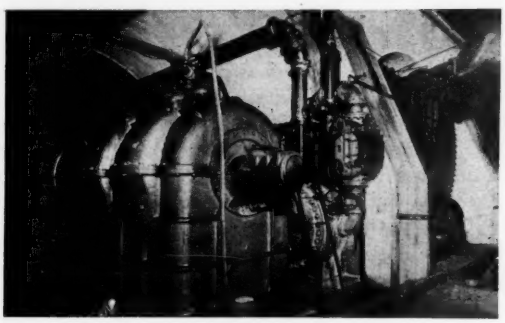


FIG. 3. MAIN CIRCULATING PUMP AND CONDENSER

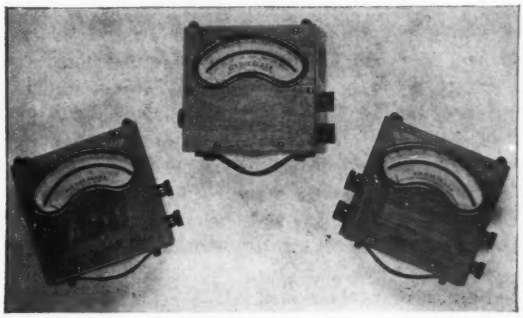
The condensing outfit comprises two shells of 28,000 sq. ft. each. In the upper portion of each condenser, 1200 sq. ft. of tubing is used for heating condensate, that is, the condensate from the bottom of the condenser is pumped through this portion of the tubes so that it is heated to substantially the temperature of the exhaust steam. Each of the shells is equipped with hotwell and air pumps, interconnected so that one or both sets may be used. A single circulating pump having a capacity of 60,000 gal. per min. and driven by an induction motor, furnishes circulating water for both condensers.

The generator is designed for 1200 r.p.m., 60 cycles, three phase, 12,000 v., and is rated at 35,300 kv.a. and 85 per cent power factor.

Small Testing Instrument

THE GENERAL ELECTRIC CO. has developed one of the smallest and lightest sets of testing ammeters, voltmeters and wattmeters for both a.c. and d.c. work to be found on the market. These instruments are called the Type P-8 and are applicable to all commercial frequencies and wave forms without appreciable error.

The ammeters and wattmeters are furnished only for series current capacity up to and including 20 amp., and although the wattmeter is single phase, it may be furnished with double voltage potential circuit if desired.



NEW SMALL SIZE GENERAL ELECTRIC TESTING INSTRUMENTS

Notwithstanding their small size, the wattmeter and voltmeter are dynamometer type, while the ammeter is of the iron vane type. The windings are magnetically shielded and equipped with an air damper of new design. The needle is very "dead beat," assuring accurate, quick readings.

The instrument case with a window in the cover over the scale plate forms the carrying case. It is of mahogany with leather carrying handle, weighs less than 2 lb. and has overall dimensions of approximately 4¾ by 4⅜ by 2 9/16 in.

Voltmeters and wattmeters of this type for 600 v. also have been developed. The cases are slightly larger to care for the additional resistance.

News Notes

THE LINK-BELT CO. has arranged with John F. Darrah, previously joint representative of this company, with E. Francis McCrossin, to take charge of the company's business in the Alabama district. His office will be found at 751 Brown-Marx Bldg., Birmingham. Mr. Darrah is a direct factory representative, and being near at hand can give prompt service to customers in his district.

E. A. KNOWLTON, formerly the Pittsburgh representative of Schutte & Koerting and until recently engaged in an executive capacity at the main offices of that firm in Philadelphia, is now with the Baker-Dunbar-Allen Co., 809 Stock Exchange Bldg., Philadelphia.

C. G. WILSON, formerly with the New York office of Elliott Co., has been appointed district sales manager of the New England district, with headquarters in the Oliver Building, Boston, Mass.

B. E. LAFOLLETTE, who has had charge of the Engineering, Sales and Advertising Departments for the Clarage Fan Co., Kalamazoo, Mich., recently resigned to go into government service, July 1, and will be located in either Philadelphia or Washington as engineer with the Requirements Division of the U. S. Shipping Board.

Books and Catalogs

AN INVESTIGATION to determine the coefficients of heat transmission of standard building materials for exterior walls has been completed by the Engineering Experiment Station of the University of Illinois under the direction of A. C. Willard, Professor of Heating and Ventilation, and L. C. Lichty, Research Fellow. The tests were conducted according to the so-called "hot-air box" method, the boxes being built of the material to be tested and of such size as to insure conditions similar to those found in actual practice. The heating was done electrically so that the input of heat could be controlled and accurately measured.

The materials tested included various sizes of tile plastered, magnesia board, cork board, wood, concrete, brick, glass with and without an air space, sheet asbestos and asbestos board. The degree to which the transmission coefficients of the various materials are affected by variations in air velocity, by humidity, and by the use of air spaces in wall is discussed, and the results of the tests are given in detail in Bulletin 102 of the Engineering Experiment Station. The publication is illustrated with diagrams and photographs of the apparatus.

Copies of Bulletin 102 may be had gratis by addressing the Engineering Experiment Station, Urbana, Ill.

"HOW DID you get that smooth gloss on the commutators?" said the G. M. to the Chief Engineer.

"Why, I use graphite brushes which don't scratch and act as a natural lubricant," was the reply.

"But don't they wear down faster than carbon brushes?"

"No. Because I use only a little pressure on them; about 3 lb. per brush gives the best results."

"How do you know?" questioned the G. M.

"Because I've tried different pressures until I found what worked best. Now I set each brush with a spring balance. I hook the balance to the brush holder and lift until the brush just clears the commutator."

The chief got his method from a little book, Adventures in Power Plant Economy, which can be had from the Jos. Dixon Crucible Co., Jersey City, N. J., by asking for booklet No. 96-M and a sample brush will also be sent on request if mention is made that you are a reader of Power Plant Engineering.

THE PENBERTHY INJECTOR CO. is offering to Stationary Engineers Associations an artistically framed photograph showing the interior construction of their Automatic Injector, on which also is given a complete and concise explanation of its working. This should be of exceptional educational value and when hung in the association room it will be a permanent answer to the question, "Why does an injector work?" The supply of these photographs is limited and we suggest that the secretary of each association write at once to the Penberthy Injector Co., Detroit, Mich., assuring them that it will be hung in the local rooms. The photos will be sent securely packed without charge, with transportation paid as long as the supply lasts.

WHEELER-BALCKE Cooling Towers is the name of Bulletin 109-B, just published by the Wheeler Condenser & Engineering Co., Carteret, N. J. This 28-page bulletin shows Wheeler-Balcke cooling towers of numerous designs, in capacities varying from a few thousand gallons an hour to nearly a million gallons an hour. It is shown better, in some cases, to combine natural and forced draft. Two pages are devoted to Wheeler-Barnard forced draft cooling towers, which are at times found preferable to the Wheeler-Balcke. Wherever sufficient ground area is available, however, the Wheeler-Balcke is usually considered by consulting engineers as the standard natural draft tower.

A NEW Coxe stoker bulletin, just received, shows by its illustrations an interesting application of the traveling grate idea, giving different views of the stokers and illustrating typical installations under various makes of boilers, these machines burning anthracite coal and culm at very high rating, also coke breeze at a large number of the by-product coke plants throughout the country.

Combustion Engineering Corporation will be glad to send this catalog to any interested power plant operator.

LIGHT FOR the Clothing Industry is the title of Bulletin No. 43,410, prepared by the illuminating engineers of the Edison Lamp Works of the General Electric Co., which contains the latest information as to the correct methods of lighting industrial plants, especially those devoted to the manufacture of clothing for our fighting forces at home and abroad. The bulletin is well illustrated, showing various lighting schemes most suitable for industrial purposes and the facts are brought out that to conserve the employes' health, to save coal, to increase the output and to keep the workers contented, it is necessary that a shop be well illuminated according to modern methods.

FOXBORO ORIFICE METERS for gas are illustrated and described in Bulletin 113 of the Foxboro Co., Foxboro, Mass., introducing the Foxboro mercury float type differential recording gage and also illustrating a radial planimeter and an instrument for testing the accuracy of meters.

MULTIWHIRL COOLER Bulletin 901 explains the uses and advantages of the Multiwhirl Cooler, also describing its construction, including the helical baffle, its operation and method of installing. The manufacturer is The Griscom-Russell Co., 90 West St., New York.

THE FIRST BOOKLET relating to the Lillie Evaporator, which is manufactured exclusively by the Wheeler Condenser & Engineering Co., Carteret, N. J., is just off the press. This new booklet calls attention

to the factors which make the Lillie Multiple Effect Vapor Reversing Evaporator especially suited to the concentration of waste waters or liquors in numerous industries. It explains the method of Film Evaporation, discusses the effect of multiple effect in bringing solutions to high densities, explains how the vapor reversing feature reduces incrustation troubles to the minimum, refers to the economical distillation of water, and, lastly, mentions some of the solutions that are not waste waters but which are successfully handled by Lillie Multiple Effects. Five pages of the booklet are devoted to tables that are of especial value in the evaporation industry.

A BOOKLET from W. W. Strickler & Bros., Columbus, O., describes and illustrates the Strickler ratchet pipe cutter.

STATIONARY FORGES, Section No. 108, containing 32 pages with illustrations, was lately received from Buffalo Forge Co., Buffalo, N. Y.

FROM LEWIS M. ELLISON, 214 W. Kinzie St., Chicago, we have received a 36-page pamphlet relating to Ellison draft gages.

CATALOG NO. 9 of G. E. Witt Co., 862-864 Howard St., San Francisco, Cal., contains 48 pages on regulating valves, oil-burning equipment and boiler room specialties.

A CIRCULAR relating to Crescent belt fasteners has recently been received from Crescent Belt Fastener Co., 381 Fourth Ave., New York.

"WONDER" PIPE BENDER, which bends horizontally all sizes of pipes generally used to any required degree, is described and illustrated in a folder from American Pipe Bending Machine Co., Boston, Mass.

INDUSTRIAL drinking water systems are discussed in a new folder from Armstrong Cork & Insulation Co., Pittsburgh, Pa. The company will supply copies, free of charge, upon request.

SKINNER AUTOMATIC ENGINES are the subject of a new catalog devoted entirely to the exposition of single-valve center and side crank engines, in single-cylinder type, from 50 to 600 hp. These engines are made by Skinner Engine Co., Erie, Pa.

THREE NEW BULLETINS are being distributed by Crocker-Wheeler Co., Ampere, N. J., and are available upon request, as follows: Bulletin No. 183, superseding No. 157, Motor Drive for Printing Machinery; No. 184, superseding No. 153, Direct-Current Lighting and Power Generators; No. 185, superseding No. 150, Coupled and Belt Types of Alternating-Current Generators.

THE PROPER CARE OF BELTS is the title of a booklet gotten out by the Joseph Dixon Crucible Co., Jersey City, N. J. We suggest that engineers obtain a copy for their files. As long as the original condition of life and pliability of a belt is preserved, it is worth its cost price. To neglect belts will result in a two-fold loss; a waste of power due to the inefficiency of the belts; and increased cost due to frequent belt renewals. Just now as never before it is essential that belting be given careful attention. The booklet contains helpful suggestions for getting maximum results from belts and in addition has several pages devoted to useful information of a general character.

Trade Notes

THE SEATTLE Engineering School of Seattle, Wash., is about to erect a 3-story building and garage, 120 by 250 ft., which will include full mechanical equipment of steam, gas and electrical machinery. The architect of the building is Sherwood D. Ford, Lyon Bldg., Seattle, and the president of the school is Wm. T. A. Faulkner.

THE UNITED Electric Light & Power Co., of New York City, has recently placed an order with The Westinghouse Electric & Manufacturing Co. for a 22,000-kw. turbo-generator set. The generator will be rated at 25,000 kv.a., at 85 per cent power factor, 8000 v., 3-phase, 62.5 cycles. It will be direct-connected to a Westinghouse 22,000-kw. turbine. The order includes a 40,000-sq. ft. surface condenser and the usual auxiliaries.

A NEW STEEL Split Pulley made by R. & J. Dick, Ltd., of New York City, is composed of pressed steel shapes, formed in dies, electrically spot welded, pickled to clean the steel and then dipped in a special molten spelter mixture. The arms are oval tubes, rims have tubular edges and curved crown face, with joints alined by dowels. A tubular reinforcement is formed under the center of the rim and is joined by the spokes to a tubular hub shell. Hub bushings are of spring type, hexagon for pulleys up to 5 in. diam. and round for larger sizes. Halves are held together by bolts through the hub shells, no rivets being used in the construction.

THE WESTINGHOUSE Electric & Mfg. Co., Pittsburgh, Pa., has purchased the property, business and good-will of the Krantz Mfg. Co., Inc., Brooklyn, N. Y., manufacturers of safety and semi-safety electrical and other devices, such as auto-lock switches, distribution panels, switchboards, floor boxes, bushings, etc.

The Supply Department of the Westinghouse Electric & Mfg. Co. will act as exclusive sales agent for the products of the Krantz Mfg. Co., whose business will be continued under its present name.

H. G. Hoke of the Westinghouse Electric & Mfg. Co. will represent the Supply Department at the Krantz factory.

A REMARKABLE record at driving rivets was recently made under handicap at the Morse Dry Dock and Repair Co.'s plant in South Brooklyn. Bertram Bieher, riveter, and his holder-on Eddie Hesse, with four heater boys, drove 1480 regulation size ¾-in. button-head rivets in 4 hr. and 10 min. As the men were forced to travel 34 ft. for every 18 rivets driven and worked on girders on which the rivets were 12 in. apart, the conditions were considered unusually trying in shipbuilding plant circles. Despite the handicap the men worked faster each hour until 10 min. before completing the job.

352 rivets were driven the 1st hour.
360 rivets were driven the 2nd hour.
361 rivets were driven the 3rd hour.
362 rivets were driven the 4th hour.
45 rivets were driven the last 10 min.

For a record of this kind, it is obvious that air hose plays an important part in rivet driving. It would not do to have to stop to make repairs. Peerless No. 4810 Air Hose, made by the United States Rubber Co., was used in this work.

SIGNBOARD SECTION

Quick Action Opportunities

CLASSIFIED RATES

Advertisements in the Signboard Section which come under the classifications "Position Wanted," "Help Wanted," "Salesmen and Agencies," "Patents and Patent Attorneys" and "Technical Books" will be set in type as shown below and published at the rate of

30 cents a line

each insertion, 6 words to a line; minimum sold, 4 lines.

First three words of each advertisement will be set in capital letters.

For advertising rates under other headings in this section, see column at right.

DISPLAY RATES

Advertisements in Signboard Section which come under the classifications "Equipment for Sale," "Equipment Wanted," "Educational and Instruction" and "Miscellaneous" are set in display space of the following sizes and at these rates:

1 in.	$ 4.00	4 in.	$15.50
2 in.	7.90	1 col. (8½ in.)	30.40
3 in.	11.70	2 col. (17 in.)	60.00

Not less than one inch or more than two columns will be sold in these classifications.

For advertising rates under other headings in this section, see column at left.

POSITIONS WANTED

POSITION WANTED—By master mechanic familiar with gas and steam engines, boilers and electrical machinery; capable of taking complete charge of mechanical end of large factory; 17 yrs'. experience. Age 37 yrs. Sober and in perfect health. At present employed as master mechanic of factory. Desires change on account of not liking the East and will consider only the West. Address Box 523, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 6-15-1

POSITION WANTED—As engineer in small plant; 10 yrs'. experience with Corliss and high speed engines. Familiar with d.c. generators and gasoline engines. Age 34. Married. Strictly sober and good repair man. Address F. H. Daton, 2823 Calumet Ave., Chicago, Ill. 6-15-1

POSITION WANTED—As chief engineer, 13 years' experience with Corliss and high-speed engines, electrical and refrigerating machinery. Sober and reliable. Best of references. Address Box 518, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 6-15-1

POSITION WANTED—To take charge of plant as superintendent. A1 electrician. Salary $150. For further particulars write Box 520, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 5-15-2

POSITION WANTED—By a first class man, aged 35, married, strictly sober, reliable and energetic. For the past 7 years superintendent of water, light and power plants, capable of doing any kind of work in steam or electrical engineering, meter repairing or testing, line work or inside wiring. Especially capable of managing water and light plant properties. Prefer a field where there is a chance of advancement. Address Box 522, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 6-15-1

POSITION WANTED—As oiler or assistant engineer in a power plant around New York City; 1 yr. experience as student and assistant to engineer. A. J. Benora, 38 Park Hill Ave., Yonkers, N. Y. 6-15-1

POSITION WANTED—As manager or superintendent of small plant or chief engineer in large plant. Age 29. Ten years' experience. A1 references. G. H. R., 425 Mapleton Ave., Boulder, Colo. 6 15-1

POSITION WANTED—Would like to represent some engineering specialty or electrical goods. Have display room three blocks from mill district. Will take agency on commission basis. Address H. Rookstool, 2321 N. Sixth St., Philadelphia, Pa. 6-15-1

POSITION WANTED—As superintendent of electric light plant. Twelve years' experience. Familiar with steam and oil engines, d.c. and a.c. machinery, line maintenance, etc. Address Box 526, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 6-15-1

HELP WANTED

WANTED—Central Station engineer for Indiana plant. Two, 250-hp. water tube boilers, two tandem compound engines. Position open at once. State salary expected. Address Box 524, Power Plant Engineer, 537 S. Dearborn St., Chicago, Ill. 6-15-3

WANTED—Master mechanic for large power plant; experienced in repairs and maintenance of large turbo-generators and boilers. Reply, giving full details to Box 525, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 6-15-1

WANTED—A competent refrigerating engineer in Western Pennsylvania. Must be familiar with raw water and ice making system and electric machinery. State salary wanted. Address Box 505, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf

BOILER HOUSE EFFICIENCY ENGINEER—Large pulp and paper company in Canada, with several mills, wants the services of a boiler-house and steam-plant efficiency engineer. Apply to H-21, stating age, experience, married or single, salary expected and send copies of references, which will be treated confidently. Address Box 527. Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 6-15-3

SALESMEN AND AGENCIES

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial to put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, O. tf

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf

PATENTS AND PATENT ATTORNEYS

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf

TECHNICAL BOOKS

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

EQUIPMENT WANTED

WANTED

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